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AN EXPERIMENTAL STUDY OF METHODS FOR RECORDING LABORATORY NOTES IN HIGH SCHOOL CHEMISTRY.

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THE PROBLEM.

The note-book problem has been and continues to be a perplexing one for High School teachers of Chemistry. A great many articles appear in the literature on Chemical Education concerning the best methods to use in recording notes, but practically all of the articles are based on the personal opinion of the individual writer and not on statistical evidence. A careful survey shows that the chief difference of opinion seems to be in regard to the advisability of requiring the student to write down the procedure or method followed.

A few typical examples will show this difference. Bulletin No. 26 of the Bureau of Education on "Reorganization of Science in Secondary Schools," page 39, says, "Flexibility in the keeping of notes is desirable provided the essential facts and conclusions are always included. The notes should usually include a clear statement of the problem at hand, a description of method of procedure,—a statement of results and conclusions." U. C. Greer in the School Review, 1906, pages 282-296, states, "The best work is done when the student writes a simple but full exposition of the important features of the experiment with whatever conclusions to be derived therefrom and renders it in clear English." Rowell, in SCHOOL SCIENCE AND MATHEMATICS, Volume 19, pages 525-526, expresses virtually the same opinion.

Conversely, J. Mathews, SCHOOL SCIENCE AND MATHEMATICS, Vol. 16, pages 767-768, states, "The requirement of written descriptions is one that can stand a great amount of introspective scrutiny."

The so-called "loose-leaf" manual has appeared in recent years

and has secured wide adoption. This type of manual is supported by various writers. For example, John H. Dahl, SCHOOL SCIENCE AND MATHEMATICS, Vol. 19, pages 162-163, advocates the use of loose-leaf sheets, with space for answers to be given in monosyllables or very brief statements. Elliott, in the same magazine, Vol. 17, pages 745-746, also advocates the exclusive use of loose-leaf note-books. Charles E. Dull in the preface of his "Laboratory Exercises in Chemistry," says, "The average student spends too much of his laboratory time writing a record of his experiment,—as an aid to English drill, this part of the exercise (i. e. recording of method) is considered to be quite worthless,—as an aid to the memory, its value is deemed very small."

In view of the various differing opinions and the constant problem which the note-book presents, the writer decided to undertake an experimental investigation, in the hope of arriving at some definite conclusions regarding the best method to use for note-book writeups.

GENERAL METHOD FOLLOWED.

The writer first obtained a representative number of the laboratory manuals and loose-leaf note-books in use in High Schools at the present time. These were then carefully examined in order to determine, if possible, the method advocated by the author for recording the notes.

It was found that the methods advocated could be divided into three general groups. Some of the manuals were rather indefinite in regard to the method given but if the general make-up of a manual suggested that it belonged to a certain form, it was placed there. The following are the three forms which were found to be in common use.

FORM 1.

Write the notes according to: (1) What you did, (2) What you observed, (3) What conclusions you drew, answer the direct questions in the manual.

FORM 2.

Write the notes according to: (1) Title, (2) Materials used, (3) Object, (4) Procedure, (5) Results, (6) Conclusions, answer the direct questions in the manual.

FORM 3.

Answer the questions given with each experiment in the blank spaces provided in the manual, or if these are not provided, in a separate note-book.

Eight manuals were examined which advocated the third form and all but two are published in loose-leaf form. One word answers are asked for, in part, by some of the manuals

of this group, but all require a great many answers in complete sentence form, so this difference is not great. None of the manuals of this group ask questions which require the pupil to record what he has done (i. e. procedure). For the most part these manuals ask questions only concerning, (1) what was observed, (2) Conclusions, based on observations, (3) Completion or writing of equations.

Five manuals were examined which advocated Form 1, while two were found which advocated Form 2, making in all fifteen High School manuals which were examined. Since the manuals examined include a very large percentage of those in use, it is safe to say that the three forms given are the ones commonly used by the High School students of this country. This is especially true because the average teacher usually follows the suggestions given by the author of the manual used.

Investigation I.

Method Followed.

Since the three forms for recording notes which have been listed are the ones in common use, it seemed logical that each method should be tried out experimentally, in order to determine, if possible, the best method to use.

The pupils of the Preparatory Chemistry Class of The Athens School, University of Chattanooga, were used as subjects. The first step taken was to divide the class into two groups of as near the same intelligence and ability as possible. The twenty-four members of the class were given the Otis Group Intelligence Test, Form A, and the Terman Group Intelligence Test, Form A. The following table gives the data for both groups, one of which is called Group A and the other Group B.

	Group A.	Group B.
1. Average total intelligence score	126.3	125
2. Average past school grade	B	B
3. Average age	18.48 yrs.	18.43 yrs.
4. Classification	10 Seniors 2 Juniors	9 Seniors 3 Juniors

The next step was to assign each group a definite method for note-book write-up. It was decided to have Group B use a separate loose-leaf note-book and write their notes according to the method given in Form 2, namely, (1) Title, (2) Materials, (3) Object, (4) Procedure, (5) Results, (6) Conclusions, answer the direct questions. Group A, on the other hand, was asked to use the method given in Form 3, namely, filling in the blanks and answering the questions in the spaces provided in the manual.

In order that the method of writing notes should be the only factor in which the two groups differed in instruction, the following precautions were taken: (1) Both groups were given exactly the same directions for doing each experiment. (2) Both groups performed the same experiment at the same time. (3) All writing of notes was done in the laboratory. Group A filled in the blank spaces as the experiment proceeded. Group B took rough notes in the laboratory and wrote up the experiment as soon as it was finished. (4) No manuals or note-books were allowed to leave the laboratory. (5) Both groups met together for class room instruction. (6) No diagrams or drawings were made by either group.

The following method was used in testing results: One week from the date on which the experiment was performed, both groups were given a test covering the experiment involved. Approximately one month after the experiment had been performed, the same tests were given again.

The questions were framed so as to permit the marking of a question either right or wrong. No partial credits were given. This plan was used to avoid the human factor in grading the tests. During this particular investigation fifteen experiments and ten tests were given.[1] The experiments given were for the most part taken from "Laboratory Exercises to Accompany Elementary Principles of Chemistry," Brownlee and Others, Allyn and Bacon, 1921. Each student of Group A was paired with another student of Group B, of approximately equal intelligence and ability. In case any student was absent at the time a test was given, the grade of the other member of the pair was also omitted from the record.

Results.

After one week (Average for the ten tests.)

Group B	74.07%	Group A	69.83%
Difference	4.24%		

After one month (Average for the ten tests.)

Group B	76.43%	Group A	68.49%
Difference	7.94%		

At first thought it might seem impossible for the students to do nearly as well (as Group A), or even better (as Group B), on the tests when given at a later period. However, approximately seventy-five per cent of the points given in the tests were mentioned in the text used by the class. It is to be expected

[1]The tests given together with the complete tables of results and graphs, can be found in "An Experimental Study of Methods for Recording Laboratory Notes in High School Chemistry," a Masters Thesis, unpublished, University of Chicago library.

then that the class room discussion would clear many points which had not been entirely clear the first time the tests were taken. It may be thought by some that seventy-five per cent is an unusually high percentage of laboratory points to be discussed in the text. However, one object of any High School Chemistry course should be to link up the discussion of text and class room with the work done in the laboratory. Since all of the students had the same class room instruction, this point should make no difference in the general results.

Investigation 2.

Method Followed.

The procedure used in this investigation was the same as that followed in Investigation 1. During the course of this investigation Group A was asked to record their notes according to Form 1, namely, (1) What you did, (2) What you observed, (3) What conclusions you drew, answer the direct questions. Group B was asked to use the method given in Form 3, namely, Answer the questions given with each experiment in the blank spaces of the manual. Thus Group A which had merely filled in blanks during Investigation 1, now wrote detailed notes and Group B, which had written notes in the complete form now only filled in the blank spaces of the manual. Seventeen tests were given during this investigation.

Results.

After one week (Average for the seventeen tests)

Group A	62.89%	Group B	59.06%
Difference	3.83%		

After one month (Average for the seventeen tests.)

Group A	58.22%	Group B	60.13%
Difference	1.91%		

Investigation 3.

Method Followed.

The same method of procedure was used as in the first and second investigations. This investigation was made in order to obtain a comparison of the scores of the two groups of students when using the same method for recording notes. This was done to obtain a further check on the relative abilities of the two groups.

During this investigation both groups were asked to use Form 3, namely, Fill in the blank spaces in the manual. Ten experiments and tests were used in this investigation.

Results.

After one week (Average for the ten tests.)

Group A	67.58%	Group B	68.24%
Difference	.66%		

After one month (Average for the ten tests.)

Group A	66.01%	Group B	64.82%
Difference	1.19%		

Summary.

The results obtained during the three investigations may be summarized briefly. Investigation 1 shows that the students of Group B who used the detailed write-up given in Form 2, made an average of 4.24% better scores after one week, than did the students of Group A who filled in the blank spaces of the manual only. Group B also ranked 7.94% higher on these same tests when given one month after the experiments were performed.

The results of the second investigation show that the students of Group A who wrote their notes according to the form, (1) What you did, (2) What you observed, (3) What conclusions you drew, answer the direct questions, ranked 3.83% higher after one week than did the students of Group B who filled in the blank spaces of the manual. Group B, however, averaged 1.91% higher when the tests were given one month later.

The results of the third investigation show that there was very little difference in the scores of the two groups when using the same method for recording notes. This gives further proof that the two groups of students were as equal in ability as it was possible to group them and that any appreciable difference in scores must be due to the method employed in recording the notes.

The method of using a separate note-book, with a description of the method followed in the experiment, gave somewhat better results in both the first and second investigations, so far as temporary results were concerned. The detailed write-up required by Form 2 gave somewhat better results after one month and evidently aided retention to some extent. The briefer method of note-book write-up as required by Form 1 gave no better results than merely filling in the blank spaces of the manual, so far as retention was concerned.

Conclusions.

The following general conclusions seem to be justified by the results obtained:

(1) The method of using a separate note-book, with a write-up including the procedure followed, gives slightly better temporary results.

(2) The writing of the procedure or method followed does

not appreciably aid the memory in retaining the main facts of the experiment.

(3) The many extra hours needed by the students to write separate detailed notes and by the instructor to correct them are not justified by the results obtained.

(4) The use of loose-leaf manuals provided with blank spaces to be filled in by the student during the course of the experiment is economical as a time saver to both teacher and pupil. This type of manual has the further advantage of giving practically the same results as a separate note-book.

(5) If separate note-books are to be used, they should contain only a brief statement of the object of the experiment and the answers to the questions given in the manual.

(6) The conclusions reached do not mean that pupils should not know and be able to explain experimental methods. Students need to realize the importance of proper experimental details and should be able to explain the significance of each step taken during the course of an experiment. The better manuals contain ample questions, which require a knowledge of method used. In fact the student must know the important facts which an experiment brings out before he can answer correctly the questions in the better manuals. However, a mere copying of methods, which are given in print, or even recording these in the students own words, does not appreciably aid the student in grasping the main points of the experiment and is largely a waste of time.

(7) It is realized that the conclusions reached as a result of this study must be accepted as tentative, due to the fact that the number of subjects used was small. The author expects to undertake further investigation and it is hoped that other teachers of science will conduct similar studies. When this is done permanent conclusions may be drawn.

THRIFT IS MADE A SUBSTANTIAL SUBJECT.

A comprehensive plan of thrift education has been worked out by the Los Angeles school system, and a course of study has been formulated as an aid to teachers in developing habits of thrift and establishing right attitudes toward savings. The plan is applicable to all elementary grades. The textbook is the outcome of practical experience, and suggests methods of correlating the study of thrift with other school subjects. Twenty-four member banks of the Los Angeles school savings association act as depositories, and these banks and their branches are obligated to cooperate with the schools and the school savers. In the school savings department 66,965 pupils have savings accounts, and the total deposits are $702,191.

NEW THEORY OF LIGHT EMISSION MAKES DISTANT STAR AND EYE BALL TOUCH.

A new theory of the emission of light, formulated with the aid of the Einstein view of time and resulting in amazing conclusions, was announced by Prof. Gilbert W. Lewis of the University of California who is delivering the annual Silliman lectures at Yale University here this month.

In his lectures Dr. Lewis made a survey of the concepts of science, and he had led up to the relativity theory and its applications. He pointed out that all the formulations of physics have already been reformulated under the spacetime geometry of relativity. The theory of radiant energy has in part resisted such formulation. Dr. Lewis proceeded to demonstrate that, by further extension of the Einstein view of time it is possible to bring radiation completely into accord with the new geometry.

A new and remarkable concept of the emission of light is necessary, Dr. Lewis contends. The energy of light is corpuscular and the corpuscles act entirely like material particles, nevertheless each particle obeys the laws of the interference of light. Light can never pass to a place where optical theory predicts a dark interference band. Dr. Lewis proposes that atoms do not emit light promiscuously into space but only to other atoms. It is not emission but transmission, in which the emitting atom and the receiving atom play symmetrical and equally important parts.

Dr. Lewis' new theory involves the amazing conclusion that what we do now determines whether certain light particles shall have left a star a thousand years ago although in ordinary parlance the star may have meanwhile disappeared. This seems absurd only because of our habits of using space and time, Dr. Lewis explained.

In relativity geometry the distance between the event of the emission and the event of absorption of light is zero. Because of this, Dr. Lewis said:

"My eye touches the star not in the same sense but in just as truly a physical sense as my finger touches the table."

"I do not wish to minimize the conflict between this view and that of common sense," Dr. Lewis explained. "The light from a distant star is absorbed by a molecule of chlorophyl in a leaf which has recently been produced in a living plant. We say that the light from the star was on its way toward us a thousand years ago. What rapport can there be between the emitting source and the newly made molecule of chlorophyl? Suppose by interference we prevent a particle of light from reaching a point. Do we thus prevent its original emission in just that particular direction? If so it means that we can, in a trivial way but nevertheless in principle, alter the course of what we call past events."

As a crucial test of the new theory, Dr. Lewis proposes a simple experiment based upon the pressure and interference of light. If the results of this test prove to be positive it will, like the Michelson-Morley experiment, require a great change in the traditional view of space and time, and further demonstrate the validity of the relativity geometry. The technical formulation of the new theory is embodied in a paper now in publication in the Proceedings of the National Academy.

Dr. Lewis' name is linked with that of Dr. Irving Langmuir of the General Electric Company as credited with what is known as the Lewis-Langmuir theory of the structure of the atom.—*Science Service.*

SYSTEMATIC ANALYSIS AND SOLUTION OF QUANTITATIVE PROBLEMS.

By Paul Ligda,

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(Continued from February.)

They could not write down the equations because we do not teach students to analyze statements, nor do we teach them to write equations from statements. We only tell them to do it. We seem to think that such telling is synonymous with teaching. We do not teach them the process of analysis for the simple reason that no authority has given us an analysis of the verbal problem. Authorities are too busy writing textbooks. What some authors call analysis is nothing but meticulous examination of the various steps of the solution, the finished product. The name of "post mortem examination" would be more appropriate, leaving the word analysis for the step in the solution which precedes the writing of the equation. Authors tell us what the steps are and demonstrate that they are correctly taken, but do not show us what we should do in order to take the correct steps. They omit the start. Textbooks develop the ability to solve an academic type of problems when certain cues are furnished, when there is a type problem illustrated which serves as a model or when some ready made formula has been "established" just prior to the exercises.

But this procedure does not develop power to attack problems, excepting in the case of the shockingly small minority who acquire power through some natural uncontrolled process, who acquire sound quantitative thinking processes in spite of unsound methods of instruction.

The writer is one of the fortunate few. He managed to learn to solve elementary algebra problems in some mysterious way and even acquired a depraved taste for solving every problem that he could find just for the joy of overcoming a difficulty. But when he tried to teach mathematics in high school he quickly discovered that all that he was teaching was problems and not methods of attacking problems. He was teaching the solution of equations and not the art of obtaining equations from verbal statements. The discovery led him to an investigation, the results of which were the systematic analysis and solution illustrated in these pages.[2]

Let us see how this analysis functions in his class room. Problems (3) and (4) were used in tests given by the writer. In a sophomore class of fourteen, six solved (3) and five solved (4). Of the five in the class who had not studied problem analysis in the previous terms not one succeeded in obtaining the correct results. The class was a Smith Hughes (vocational) class studying strength of materials. In their freshman year they had had one term of shop arithmetic and one term of algebra supplemented by shop problems. In their sophomore year they had studied shop mathematics, mostly formula work. This description of their previous training is given in order to show that the class was not trained to the minute in the solution of problems of the kind found in academic books. It was purely a test of power.

In the low freshman class of 19, seven solved (3) correctly, and five of these solved (4). A few more gave correct answers, but, their explanations being unsatisfactory for the reasons given later in this discussion, they were not counted with the successful five or seven.

The previous training of this class was very meager when considered from the conventional point of view. Most pupils had earned very low marks in their arithmetic work and were markedly deficient in the machinery of arithmetic. The first two quarters of the high school term had been spent in a review of arithmetic and in the solution of shop problems through the use of formulas, the analysis being supplied by the writer. But, and here is an important point, the aim throughout the instruction had been to make the pupils realize their deficiencies in mathematics and their ignorance of fundamental concepts. The writer's theory is that the easiest as well as the most effective way to teach is not to teach but to induce the class to learn of its own accord. For the five weeks preceding the test they had studied equations, simple and simultaneous, and also the systematic attack and analysis of academic verbal problems. The latter were used in preference to shop problems because of their structural simplicity and the greater familiarity of the class with the quantities involved. That is, academic problems were chosen because they were easier to analyze than practical problems, better suited for beginners.

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[2]For a more complete description of the method and the discussion of the steps the reader is referred to the writer's "The Teaching of Elementary Algebra," Houghton Mifflin, 1925. The detailed analysis of problems varying in difficulty from the simplest sixth grade problem to problems leading to simultaneous quadratics and cubics are given. All problems, practical and academic, are analyzed and solved by one method without any consideration of "type."

Under these conditions an extraordinary amount of work was done by the majority, with real thinking as a criterion. Like all classes this class enrolled a few slackers who could not be induced to exert themselves, at least not by the writer. But since we meet similar conditions in all classes, we may commit these slackers to a well deserved oblivion. The solutions now follow.

Problem 3. A train leaves a station and travels at the rate of 40 miles an hour. Two hours later a second train leaves the same station and travels in the same direction at the rate of 55 miles an hour. When wlli the second train pass the first?

Solution 1. The first train travels 80 miles before the second train starts. The second train reduces this lead by 15 miles every hour. Therefore it will take 80 /15 or 5 1 /3 hours to overtake the first.

Discussion. The solution shows the clear recognition of the formula $t = d / r$. The student considered the solution so simple that it did not require an equation. Should it take six years of training to solve this problem? Incidentally the writer wonders if Dr. Hotz knew of this solution when he standardized his test. When problems can be solved in two or more different ways is equal credit given?

Solution 2. (As solved by pupils using the writer's method. The material in parentheses is intended to explain the steps.)

Step 1. Two situations: the two trains.

Step 2. Quantities (involved): distances, times and rates.

Step 3. Formula used D = RT for the fast train, and $d = rt$ for the slow train. (Functional relationship involved.)

Step 4. (Arranging the formulas vertically for tabulation, comparison of like quantities, or search for equational relationship, and directions for analysis.)

$$\begin{array}{ccc} \mathrm{D} & \quad & d \\ \shortparallel & & \shortparallel \\ \mathrm{R} & & r \\ \times & & \times \\ \mathrm{T} & & t \end{array}$$

(We then ask ourselves the following questions *suggested in succession* by the tabular arrangement: 1. What does the statement say about the distances that can be expressed in an equation? Answer: that they are equal, or $\mathrm{D} = d$. This is immediately written in the diagram. 2. What does the statement say about the rates, etc.?)

1) The distances are equal, $D=d$

2) The rates are 55 and 40. $R=55$ and $r=40$.

3) The fast train takes two hours less than the slow train. If we add 2 to the time of the fast train it will be equal to the time of the slow train. $2+T=t$.

$$\begin{array}{rcccl} & & D & = & d \\ & & \| & & \| \\ 55 & = & R & & r = 40 \\ & & \times & & \times \\ & & 2+T & = & t \end{array} \qquad (1)$$

(Symbolic) solution.

$$\begin{aligned} D &= d \\ RT &= rt \\ 55T &= 40t \\ T &= 8t/11 \end{aligned}$$

Substituting this value of T in (1), etc.

By the traditional procedure the problem would be solved as follows: Let $x=$ the number of hours that the second train travels, then $x+2$ is the number of hours that the first train travels. Then $55x$ is the distance traveled by the second train, and $40\ (x+2)$ is the distance traveled by the first train.

By the conditions of the problem, (or, "Since the distances are equal," or, "Statement of equality," or "relation between numbers," or "Relation of equality," etc.)

$$55x=40\ (x+2), \text{ etc.}$$

The traditional procedure does not show:

1. The beginning of the solution; the plan of action. The functional relationship $d=rt$ is used twice but not explicitly stated. The learner uses it unconsciously because the problem is one of the group labelled "Uniform motion problems." But when the problem is mixed with "work problems," "proportion problems," without a cue, he cannot remember the types.

2. The essential relationship $D=d$ is neither explicitly brought out nor emphasized. Words like "by the conditions of the problem," etc., are anything but meaningful to pupils. "Relation of equality" is also bewildering for we find two such relations in the problem: $D=d$, and $2+T=t$, hence we can solve in two ways. Note finally that the statement does not state explicitly that the two trains travel the same distance. This kind of implied relationship is frequently met in problems, yet no textbook compiler ever pointed out this troublesome feature. The children learn it inductively—sometimes.

According to our experts children learn all such difficult points inductively. Later they are found to have forgotten something,

for they cannot solve problems outside of the class room or without the book. Unfortunately, since we have a large number of books on other subjects which are not written in such a way as to remind the pupils of the material that they learned (so inductively that they do not even know that they learned it or what it is), the results are rather disastrous. Thus the teacher of physics finds that his pupils do not seem to know fundamental principles. They know some sentences but do not use the thoughts contained in the sentences because we do not train them that way.

The writer's method of analysis on the other hand does not avoid the troublesome places. The relation diagram is not ready for the symbolic solution until every quantity therein is either fully described (thus $R=55$), or related (in the same equation as the *like* quantity of the other situation). The student is told, and also quickly learns from every problem, that there is not any use in starting the symbolic solution before the analysis is complete. He may start the analysis at any point, but the empty spaces of the diagram inexorably force him to ask himself the question "what does the statement state or imply about the distances, the rates, or the times?" He must find every relationship before he can solve the problem.

In the National Committee Report, page 65, Professor Hedrick advises the teacher "not to pass any instances in which one quantity is related to another, or in which one quantity is determined by one or more others, without calling attention to the fact, and trying to have the student 'see how it works.'" When the writer's method is used the teacher does not need to point out relationships. The pupils find the relationships themselves and use them—after they have been told clearly what they are expected to do. Can it be denied seriously now that the writer's method does develop "the habit of looking for and using relationships, the habit of thinking more clearly about the quantities with which he will have to deal in real life?" . . . (page 64 of Report).

Furthermore it should be noted that this is real analysis, real breaking of the problems into parts *before* solving, not a post-mortem examination of the results and idle speculation of what would happen if some quantity were varied. The student does not have to attack the problem as a whole, he nibbles at the various parts. This explains the reason why beginners can solve problems while college seniors and graduates fail. The

latter may be compared to workers trying to carry a load of 500 lbs. Only the strongest succeed. The boys carry the same load piecemeal. It takes a little longer but the important point is that they move the load and are strengthened by the exercise. Solutions obtained by systematic methods are not usually short and brilliant as are the solutions obtained by experts, but on the other hand beginners can almost always depend upon obtaining a solution and upon gaining power in quantitative thinking.

This analysis soon teaches the pupil to find for himself whether multiplication or division should be used in given problems, at present a perplexing question with nearly all of us who are not occupied in juggling numbers all day. It is recommended that teachers of arithmetic investigate the possibilities of the method in this direction.

But let us return to problem 4. It will give us additional food for thought.

4. A merchant has two kinds of tea, one costing 50 cents and the other 65 cents per pound. How many pounds of each must be mixed together to produce a mixture of 20 pounds that shall sell for 60 cents a pound?

The following kind of answer was considered unsatisfactory although the correct answer was obtained:

Solution 1. The price of the tea must be reduced one-third of the difference between 65 and 50 in the case of the 65c tea, and raised two-thirds of the same difference in the case of the 50c tea. Therefore we must use twice as much 65c tea as 50c tea. In 20 lb. 2/3 must be 65c tea, etc.

This is not satisfactory because, if the numbers had been 51c, 59c, and 64c respectively, instead of 50, 60, and 65, the pupils would have been unable to extricate themselves from the resulting tangle of fractions.

Solution 2. (Fundamental) statement.

1) The total cost = cost of one pound $\times$ number of pounds.

2) Formula: T = C N for each kind of tea and for the mixture.

3) We add n pounds of 65c tea to one pound of 50c tea. We have then a mixture weighing $(1+n)$ pounds and costing $50+65n$ and having an average cost of 60 cents per pound.

4) The 20 lb. mixture is one condition of affairs and the $(1+n)$ pounds is another condition of affairs related to the first by the fact that the cost per pound in each case is 60 cents. That is (reading equations vertically)

$$\begin{array}{ccc} (50+65m) & & 1200 \\ \parallel & & \parallel \\ 60 & = & 60 \\ \times & & \times \\ (1+\quad n) & & 20 \end{array}$$

$$\frac{50+65n}{1+n} = \frac{1200}{20}$$

Simplifying

$$50+65n = 60(1+n)$$

whence $n=2$. We have to use 2 pounds of 65c tea for each pound, etc.

The objection to this solution is that too much is done mentally that is beyond the control of the teacher. The reasoning is correct, but what caused the student to reason this way? How was the plan formed? Short cuts and dimly perceived plans are of doubtful value in the elementary training process. It must be recognized that if we are to prepare for difficult problems we must insist upon the use of the tools through which difficult problems are solved: clear thoughts about the quantities and relationships involved, even though the problem can be easily solved by imitation, or through some imperfectly comprehended short cut. System and method far outweigh amount of ground covered and speed so far as ultimate development of power is concerned.

It is interesting to note that the above solution really solves the far more difficult problem: In what proportion should the two kinds of tea be mixed?

Let us now examine the traditional method of solution. Let $x=$ the number of pounds of the 50c tea used, then $20-x=$ the number of pounds of the 65c tea used.

By the conditions of the problem

$$50x+65(20-x)=20\times 60, \text{ etc.}$$

Short and brilliant! The only hitch is that children do not seem to be able to write the equation after writing the magic words: "By the conditions of the problem." Why?

(1) Because no one ever showed them what was meant by "the conditions of the problem."

(2) Also there is a process of mental organization and substitution involved. Let us examine another method which will bring out this latter point.

Let x = number of pounds of 65c tea, and y = number of pounds of 50c tea.

Then, by the conditions of the problem

$$x+y=20$$

and

$$65x+50y=1200, \text{ etc.}$$

This is simpler than the first. Yet beginners are assigned problems of this type and are expected to substitute mentally *before they have learned to substitute on paper*. The reason for this is that simultaneous equations are taught at the end of the course.

The traditional organization of the subject matter is subordinated to the all-important equation solution. This automatically forces the use of two classes of problems:

1. Problems so simple of solution that the pupil does not learn anything from them.
2. Problems so difficult that they cannot be solved by the average child because of the mental process of organization and substitution required.

Solution 3. We can make the following statements:

1. The sum of the weights is equal to the weight of the mixture.

$$N+n = 20.$$

2. The cost of the 65c tea together with the cost of the 50c tea equals the cost of the mixture

$$65N+50n=1200, \text{ etc.}$$

This is seen to be superior to the two traditional solutions given above. The boy perceived "the conditions of the problem," that is the relationships, clearly enough to state them verbally. The objection to this solution is that there is no indication of the plan of attack, of the association that caused the boy to select and paraphrase the right elements of the statement. The mental process is not under the teacher's control. Furthermore there is a mental substitution which will become apparent in the next solution.

Solution 4. By a student using the writer's general method.

1. Three situations (are described in the problem): The two kinds of tea and the mixture.
2. Quantities involved in each situation: total cost, cost per pound, and number of pounds. (The recognition of these quantities leads to step 3.)
3. (Characteristic formula, governing each situation, and determined from the fundamental relationship: Total cost = cost of one pound × number of pounds.)

Formula: $T=C\ N$.

4. (Arranging formulas vertically)

$$\begin{array}{ccccc}
T_1 & + & T_2 & = & T_3 \\
\| & & \| & & \| \\
C_1=50 & & C_2=65 & & C_3=60 \\
\times & & \times & & \times \\
N_1 & + & N_2 & = & N_3=20 \quad (1)
\end{array}$$

(The numbers and relating signs are written after the following analysis.)

5. Analysis (We can make the following statements, after asking ourselves the following questions suggested by the tabulation: What statement can we make about total costs, etc.)

A. The sum of the costs of the teas is equal to the cost of the mixture

$$T_1+T_2=T_3$$

(which is immediately written in the above diagram)

B. The sum of the weight is equal to the weight of the mixture

$$N_1+N_2=N_3$$

(which is immediately written in the above diagram)

C. The costs per pound are 50, 65, and 60 (respectively, that is)

$$C_1=50,\ C_2=65, \text{ and } C_3=60$$

D. The weight of the mixture is 20 lb.

$$N_3=20$$

(Simplified diagram, sometimes used by beginners)

$$\begin{array}{ccccc} T_1 & + & T_2 & = & 1200 \\ \Vert & & \Vert & & \Vert \\ 50 & & 65 & & 60 \\ \times & & \times & & \times \\ N_1 & + & N_2 & = & 20 \end{array} \qquad (1)$$

6. Solution (All the quantities being described or related, we can proceed with the symbolic solution)

Formula $\quad T_1+T_2 = 1200 \qquad (2)$

(substituting by means of the vertical equation, the process that beginners are supposed to learn inductively, without being shown or told; the substitution performed mentally)

$$50N_1+65N_2=1200$$

(We have used all the relating statements but (1)')

Multiplying each side of (1) by 50 (or by 65)

$$50N_1+50N_2=1000$$

Subtracting from (2) etc.

The relating diagram is now seen to be the complete translation of the verbal statement into algebraic symbols. It gives every quantity and relationship implicitly or explicitly involved, rearranged systematically, that is prepared for the manipulation. It also furnishes the student a number of hints on what to do next. It assists his thought to take a definite direction. The student's thinking process is completely under the teacher's control, for the latter knows the thought to be expressed, the way that it must be expressed and the result of the thinking. After the unknown has been found the checking is also greatly facilitated by the diagram.

One unexpected by-product of the method is that the pupils' power to analyze soon outstrips their meager manipulative skill. In an incredibly short time they become capable of obtaining correct equations that they cannot solve. The writer usually does their equation solution for a while, until some bright chap asks for an organized method by means of which equations can be solved. The class becomes aware of its lack of manipulative skill and tackles the academic drill enthusiastically. They perceive its use: to complete the solution of problems. How does this procedure compare with other methods of producing interest in the subject? Is it sensible to teach equation solution before the pupil clearly perceives that he needs equations?

How does this method function later? One student was found to use the method in his university work, when obtaining equations. After the equations were obtained and the problem was thoroughly understood, he would translate the equations into more conventional equation using the traditional x and y in order to avoid wounding the tender feelings of his instructor. The instructor did not know apparently that the National Committee recommends the use of initial letters. (Page 82, art. 8.)

One curious objection to the method was made by a college instructor: "Your method destroys analysis. It destroys the value of mathematics as a disciplinary study. The pupils can solve the problems so easily that mathematics loses its training value.

This objection may be answered as follows:

It does destroy the traditional so-called analysis so dear to the savant that he does not want to teach anything else. If the problems become too easy, we can readily give more difficult problems from more advanced textbooks. The rest of the objections are not worth answering. Results speak for themselves: compare the performances of the twenty-six seniors and graduates with the 19 high school low freshmen.

Changing the Setting of a Problem.

This analysis of problems has produced several interesting by-products. One of them is the discovery that entirely different problems may have the same structure. This property will be of great interest to compilers of problem solving ability tests and to the users of these tests.

Suppose that we take problem 4 and change its setting while keeping the relationships and numbers in the same relative positions.

Three boys are playing teeters. One boy weighs 20 kilograms, which is as much as the other two together, and is seated alone on one side of the fulcrum at a distance of 60 decimeters from the fulcrum. The other two boys are seated on the other side, 65 and 50 decimeters respectively from the fulcrum. What are the weights of the two boys?

Pupils trained by the writer's method solve it as follows:
Fundamental statement
Since the two sides balance the moments are equal

$$M_1 + M_2 = M_3$$

The quantities involved are moments of force, forces, and leverarms
The characteristic formula is $M = F\,L$. Moment = Force $\times$ Leverarm
The relation diagram is (when completed)

$$\begin{array}{ccccc} M_1 & + & M_2 & = & M_3 \\ \parallel & & \parallel & & \parallel \\ L_1 = 65 & & L_2 = 50 & & L_3 = 60 \\ \times & & \times & & \times \\ F_1 & + & F_2 & = & F_3 = 20 \end{array}$$

And the rest of solution exactly parallels the solution of the tea problem.

Several interesting comments may be made. If we were to submit the two problems to a number of teachers of mathematics after taking the precaution of using different numbers, they would probably agree on the fact that the second is far more

difficult to solve than the first. In a test the second would be placed at the end of the list where the most difficult problems are located. Yet the structures are identical and the symbolic work is similar in both. The difficulty of the second is due to the fact that (comparing the quantities in corresponding positions in the two diagrams) while the total cost of a certain number of pounds of tea is a familiar quantity, the moment of a force is a quantity so unfamiliar that we have no unit of measurement assigned to it. The functional relationship $T=CN$ is well known and used continuously even by people not aware of its equational form. The formula $M=FL$ is very seldom seen even in physics books of the inductive type. The relationships in one case are of a familiar type and the opposite may be said about the other case. The second problem then is more difficult to solve, owing not to its purely mathematical feature, but to unfamiliarity with the quantities involved. The fundamental principle of association then is entirely overlooked by many compilers of tests and of textbooks: We cannot perceive the relationships between quantities that are not familiar to us. Since we are not able to perceive them we can not express them in algebraic language. This principle leads us inevitably to one conclusion: we cannot express in algebraic language something that we cannot first express in plain English. We cannot express verbally or symbolically something that we do not perceive, and the final conclusion is: We cannot look for relationships before we are told what relationships are and how to find them in verbal statements. How many textbook writers explain and illustrate what is meant by the word "relationship" that they use so profusely in their advertising circulars, their prefaces and even throughout their texts?

The reader may now draw his own conclusion about the seat of the trouble in mathematical instruction. The baiting and ridiculing of teachers and pupils by self styled experts who later impose those very methods and texts which aggravate the situation and make it more hopeless, must cease. Many teachers perceive very clearly that the present situation is created by the fact that they are told to teach the thinking process to children and at the same time are also told the means that must be used, methods that cannot possibly develop power in thinking. There are plenty of teachers in the world capable and desirous of improving the present situation if they were only given a voice in the readjustment of mathematics to modern

conditions. But in institute meetings, committee work, and educational publications they are mostly elbowed out of the way by enterprising individuals having the gift of gab, facility with the pen, and well trained in the art of stringing together sonorous or well constructed sentences that do not mean anything in particular but that in the estimation of unthinking people pass for evidence of deep thinking. These pushing individuals are actuated by one motive: to keep themselves in the limelight and to get their methods and books adopted regardless of the effect on our school population. That they do not know the mathematics that they speak or write about is clearly demonstrated by one fact: they do not seem to be able to visualize the destruction and waste caused by their incompetence and selfishness.

What are we going to do about it?

MANY SHORT COURSES FOR GENERAL CULTURE.

Stories of personal experiences in foreign lands obtained from pupils and their parents enabled a Los Angeles teacher of a school where 12 nationalities were represented to get a point of contact in dealing with a group of overage retarded children whose parents had recently come to this country. Home interest was aroused and a valuable collection of foreign customs and experiences obtained which were made the basis of study in many subjects, especially in English and history.—*School Life.*

VOCATIONAL AND ACADEMIC TRAINING FOR ILLITERATES.

In connection with the "eradication of illiteracy" campaign in Oklahoma, the State department of civilian rehabilitation announces that assistance is available to crippled persons above 16 years of age who need training in gainful occupations. This includes illiterates. It is stated that a crippled illiterate adult may begin learning weaving, hemstitching, shoe repairing, broom and mop making, mattress making, upholstering, chair caning, rug weaving, etc., while learning to read and write.

TO TEACH ENGLISH AS AMERICANS USE IT.

Phonographs are employed in teaching English in many schools in the Philippines. In one division, that of Nueva Ecija, island of Luzon, they are used in this way in 22 central schools and 17 barrio schools. Educational authorities in the islands desire that the English spoken shall be as similar as possible to the language of the United States, and, as it is impossible to employ the thousands of American teachers that would be required to bring this about, the use of phonographs with correct American-English records is strongly advocated.

CURRICULUM STUDIES ON THE PLACE OF RADIO IN SCHOOL SCIENCE AND INDUSTRIAL ARTS.

By Earl R. Glenn,
Department of Natural Sciences, Teachers College, New York,
and
L. A. Herr,
Industrial Arts, The Lincoln School of Teachers College.

(Continued from February.)

As a result of our reported results, there was literally an epidemic of "lighthouse" receivers among the various classes in the school with which we are associated. A rear view of a set of this type is shown in figure 10, and a sample performance of this one-tube regenerative circuit, with head telephones, is given in figure 11.

At this stage the number of radio fans had greatly increased, and accordingly the "birdies" from sets of this type could be heard at any time. If a radiating receiver was not unknown to the average person, it was certainly never mentioned by him. Our sets must have contributed a fair share of radiation to the musical melodies of canary land.

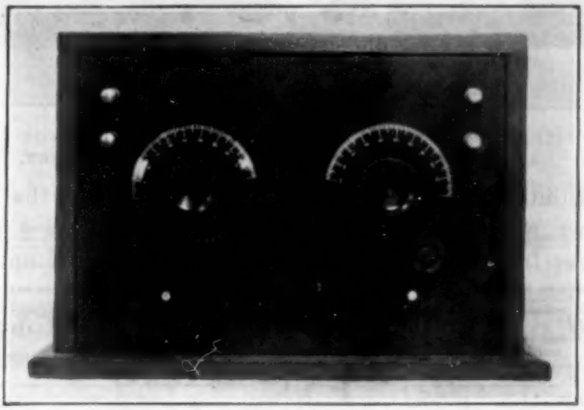


Fig. 12. A Reinartz One-Tube Receiver. A Squealing Nuisance in the Hands of a Layman.

V. The Reinartz Circuit.

A receiver known as the Reinartz type came to our attention, and like all progressive radio fans we proceeded straightway to collect the "99" switch points required for constructing it.

This receiver was recommended to us as being a wonder for bringing in distant stations and while it had a great array of switch taps and accompanying wires, we decided that perhaps

we should take one more chance. Several different types of Reinartz one-tube receivers were constructed in the attempt to get one that would satisfy our desire to hear distant stations and yet be reasonably easy to operate, but in the end we were not satisfied. A simplified type of Reinartz receiver which we found unusually good is that shown in figures 12 and 13.

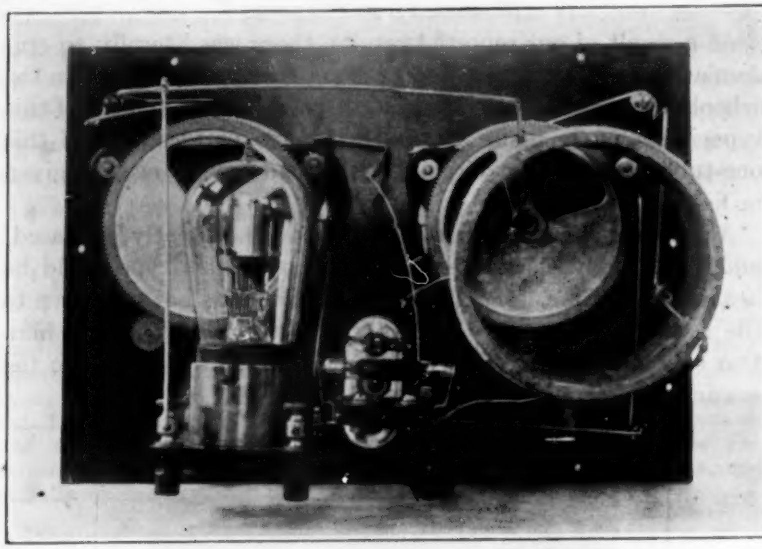
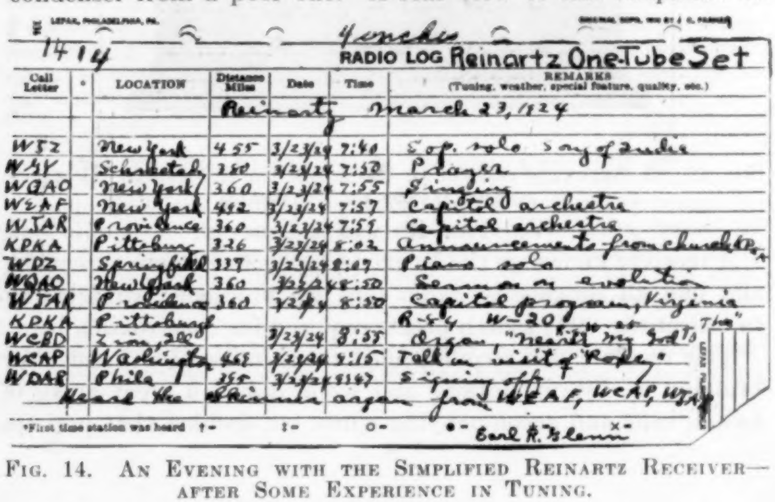


FIG. 13. REAR VIEW OF REINARTZ RECEIVER. GOOD FOR DISTANCE AND SELECTIVITY IN THE HANDS OF AN EXPERT.

We attribute the success of this receiver to the fact that, at this stage, we were reasonably sure that we could tell a superior condenser from a poor one. A rear view of this simplified set



Yonkers

1414 RADIO LOG Reinartz One-Tube Set

Call Letter	*	LOCATION	Distance Miles	Date	Time	REMARKS (Tuning, weather, special feature, quality, etc.)
			Reinartz			March 23, 1924
WJZ		New York	455	3/23/24	7:40	Sop. solo Song of India
WGY		Schenectady	380	3/23/24	7:50	Prayer
WQAO		New York	360	3/23/24	7:55	Singing
WEAF		New York	492	3/23/24	7:57	Capitol orchestra
WJAR		Providence	360	3/23/24	7:59	Capitol orchestra
KDKA		Pittsburg	326	3/23/24	8:02	Announcements from church [illegible]
WBZ		Springfield	337	3/23/24	8:07	Piano solo
WQAO		New York	360	3/23/24	8:50	Sermon on evolution
WJAR		Providence	360	3/23/24	8:50	Capitol program, Virginia
KDKA		Pittsburgh				R-84 W-20 [illegible]
WCBD		Zion, Ill.		3/23/24	8:55	Organ, "Nearer my God to Thee"
WCAP		Washington	468	3/23/24	9:15	Talk on visit of [illegible]
WDAR		Phila	355	3/23/24	9:47	Signing off

Heard the Skinner organ from WEAF, WCAP, WJAR

*First time station was heard †= ‡= O= ●= Earl R. Glenn ×=

FIG. 14. AN EVENING WITH THE SIMPLIFIED REINARTZ RECEIVER—AFTER SOME EXPERIENCE IN TUNING.

is shown in figure 13. As a regenerative receiver this satisfied our desire for distance. A sample performance of this set in New York City is shown in figure 14.

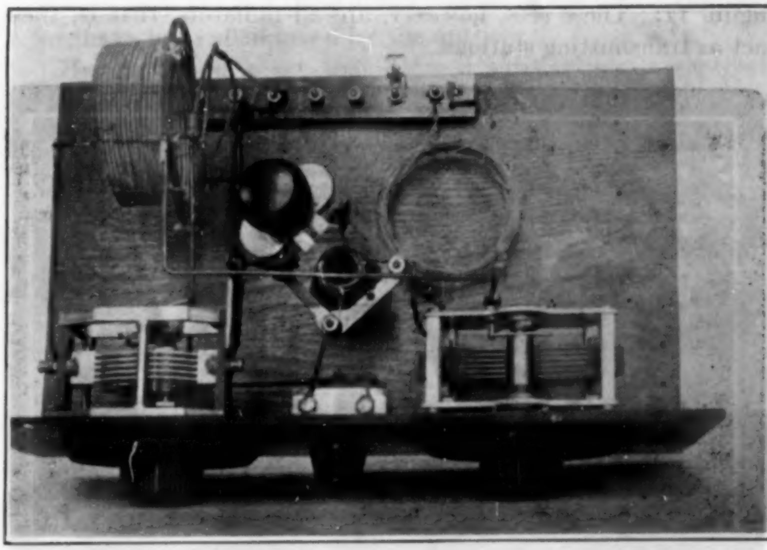


FIG. 15. A SHORT WAVE RECEIVER AS CONSTRUCTED BY A PHYSICS STUDENT.

This set in a variety of forms has been made by pupils of all ages in various classes.

Figure 15 shows a top view of a single-tube short wave receiver constructed by a physics student. This student has listened to

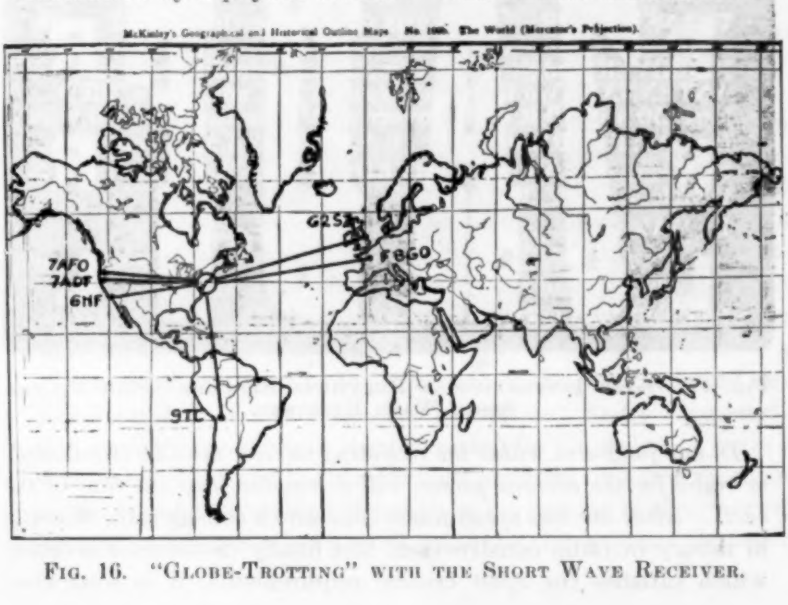


FIG. 16. "GLOBE-TROTTING" WITH THE SHORT WAVE RECEIVER.

amateur stations all over the United States and in a great many of the foreign countries (Fig. 16) with this set.

Typical verification cards of its performance are shown in figure 17. These sets, however, are all radiators, that is, they act as transmitting stations.

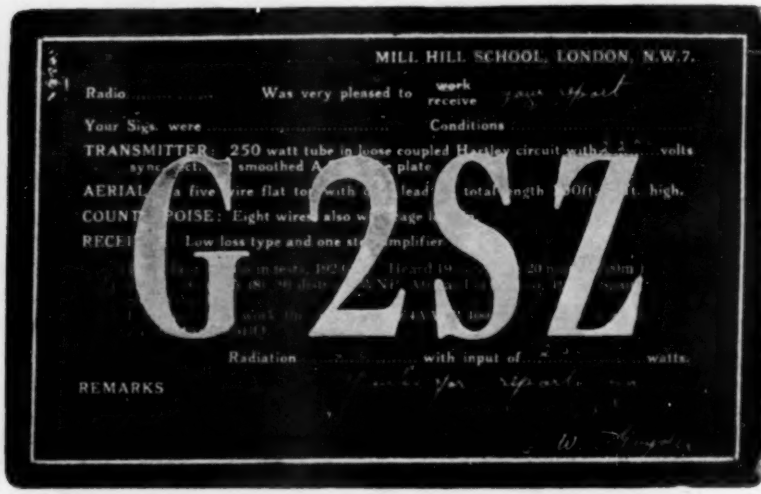


FIG. 17. SOME INTERNATIONAL RELATIONS BROUGHT ABOUT BY THE SHORT WAVE RECEIVER.

In our judgment, either the radiating receiver must be eliminated, or radio for the average person will disappear from the face of the earth. After one has spent much time and a considerable amount of money in radio construction, and finally discovers a receiver which satisfies the most critical requirements, it is somewhat

annoying to say the least, to listen to all manner of "cat-calls" and other zoological sounds during the progress of a concert given by a great musical organization. Our radio motto is "Down with the radiating aerial," so all of the sets described so far, have been abandoned by the authors.

Having found a set that seemed satisfactory, except with respect to intensity of sound, the natural thing to do was to use an amplifier and get more volume. Once again we started on a new line of attack and spent some money on various types of two-stage amplifiers, one of which is shown in figure 18. This outfit satisfied our ambitions for a short time.

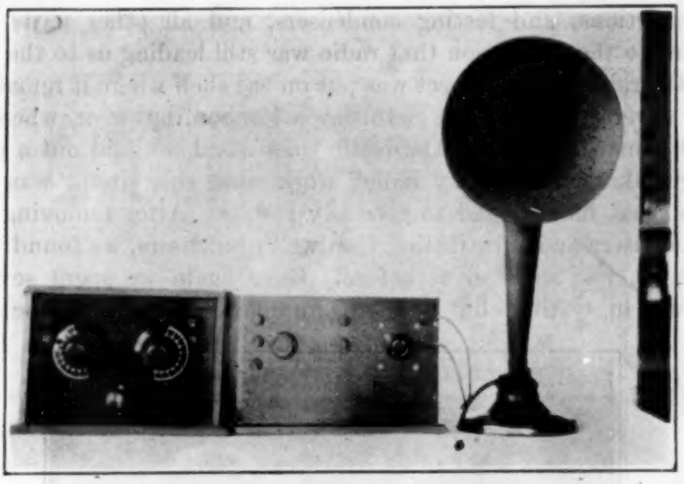


FIG. 18. A THREE-TUBE OUTFIT FOR THE LOUD SPEAKER. FAIR VOLUME, POOR QUALITY, PLENTY OF NOISE FOR THE NEIGHBORS.

VI. THE HARKNESS REFLEX RECEIVER.

At this period there was another very decided lull in the constructional activities of the authors. Our good money had been spent and yet we had not discovered a school radio receiver which satisfied our ambitions. Radio as a topic of conversation was more or less abandoned for several months. It is true that we exchanged experiences occasionally with other radio enthusiasts when forced to do so, but we had a feeling that the radio writers had led us into a blind alley.

Somewhat previous to this time one of the authors found on a news-stand a certain magazine known as "Radio Broadcast," and having been more or less interested for a number of years in first class samples of the printer's art, decided that this magazine would be worth watching although in the opinion of the observer, no radio magazine of such merit would be able to stand the test of

time and competition. We found great pleasure in reading the various pages of this magazine, from time to time, and on one occasion when we came across a beautifully illustrated article concerning a receiver known as the "Harkness reflex knockout receiver," we were greatly interested.

Later one of the authors ventured the suggestion that it might be worthwhile to take another chance since this article seemed to ring true. Well, we did so, and after much travelling over New York City we finally secured the necessary parts for the construction of this set. In a night or two the new receiver was finished but when it was tested not a sound could we hear. After many futile attempts at checking diagrams, examining connections, and testing condensers, and all other parts, we came to the conclusion that radio was still leading us to the end of the rainbow, so this set was put on the shelf where it remained for several weeks. One Saturday afternoon, however, when we felt somewhat more enthusiastic than usual, we laid out a plan for making this "balky mule" work since this circuit was the first that had refused to give any results. After removing the condensers and substituting Cardwell condensers, we found that the set was as dead as before. Once again we spent several hours in testing, but without audible results from the set.

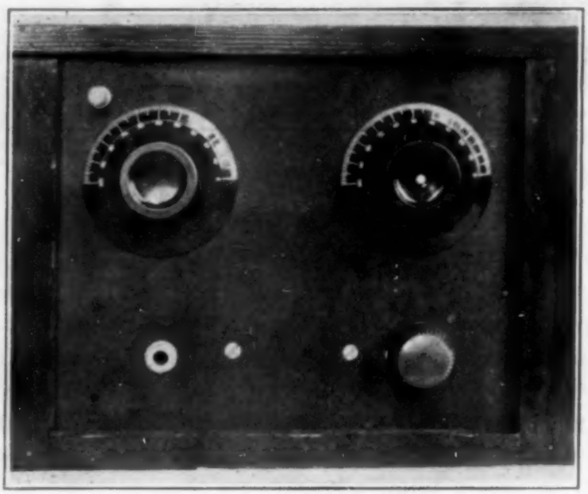


FIG. 19. THE HARKNESS REFLEX RECEIVER. THE BEST SINGLE-TUBE SET WE HAVE FOUND SO FAR.

Finally we concluded that the only possible difficulty could be in the transformer. Accordingly we removed it, and substituted an old Acme transformer and lo, and behold! great volumes of

sound greeted our ears! When the loud speaker was attached to the set, we verified all the claims made by the author of the original article.

A few simple tests satisfied us that we had found the most satisfactory one-tube receiver thus far constructed. We tried all the loud speakers which we had accumulated, at that time. Some of these we had made. They are shown in figure 21. However, all our efforts in loud speaker construction have yielded zero returns in satisfaction. We buy the loud speakers now, but with some caution. All of our efforts to get distance records on the loud speaker with this set have not yielded the returns which we have been eager to secure. And so the search for the ideal receiver continued.

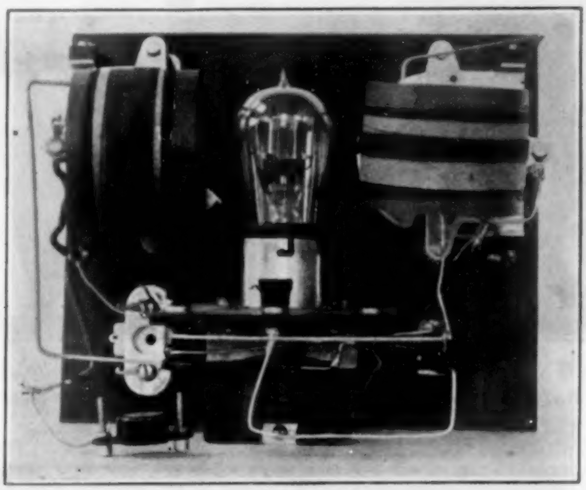


FIG. 20. REAR VIEW OF THE HARKNESS REFLEX RECEIVER. A COMPACT ARRANGEMENT OF PARTS,

VII. THE ROBERTS, REFLEX RECEIVER.

At this stage the authors had become habitual readers of the "Radio Broadcast" and followed the progress of radio from month to month in this and many other magazines. When Dr. Roberts published the first article on his new set in the April, 1924, issue of "Radio Broadcast," we were struck at once by the article itself, and the results reported in it. While our bank account for radio purposes was very much depleted, we decided that we should take another chance, at once, so we purchased a full set of the best parts that we could obtain, and on the afternoon of Decoration Day, 1924, and the day following, we constructed this set with all possible speed. Between twelve and

one o'clock that night, we put the set on the testing board and grabbed an old pair of dilapidated telephones for the great adventure. A twist or two of the condenser dials brought in Northfield, Minnesota, with such volume that our eardrums

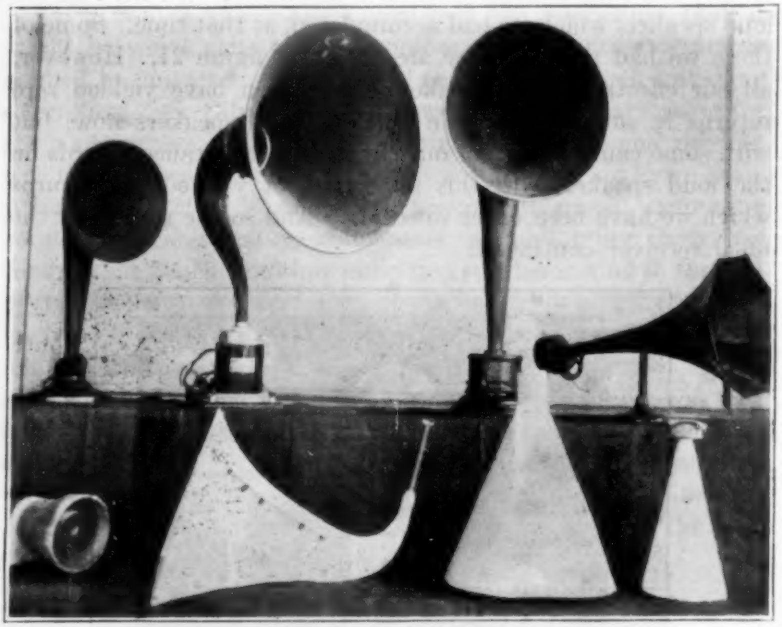


FIG. 21. SOME HOME-MADE AND FACTORY-MADE LOUD SPEAKERS THAT WE TRIED. DON'T MAKE ONE, BUY WITH CAUTION.

FIG. 22. THE PHYSICAL EDUCATION TEACHER MAKES A NEAT PANEL IN HIS FIRST ATTEMPT.

rang as though an explosion had occurred. When the telephones were laid on a stool near by the volume was sufficient to fill a large room, although only two tubes were being operated. Before the testing was completed, we felt sure that our hopes had been realized, and that we had discovered an ideal receiver for school purposes.

Figures 22, 23, and 24 show various types of Roberts' receivers which have been built from the authors' models by students and teachers. In the year that has elapsed since we constructed the first set, the following Roberts' receivers have been made by

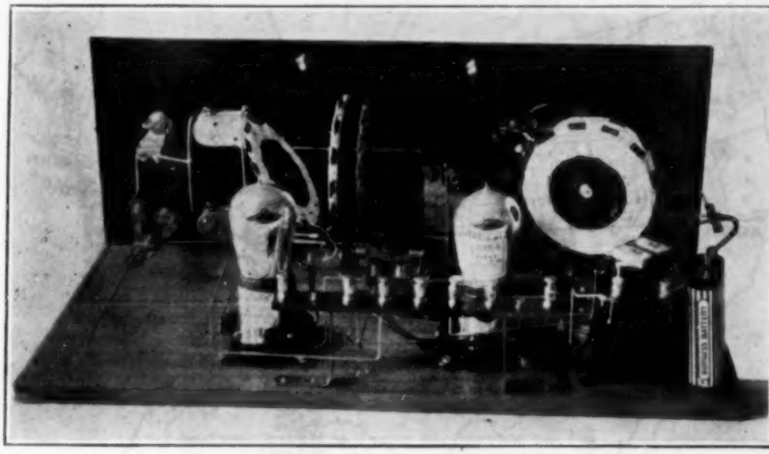


Fig. 23. A Rear View of the Physical Education Teacher's First Copy of one of the Author's Sets.

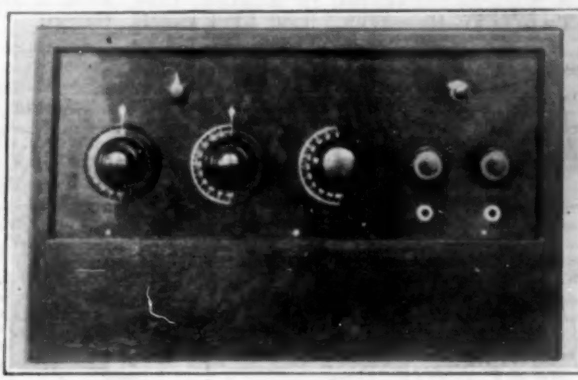


Fig. 24. A Roberts' Two-Tube Receiver and Cabinet made by the Biology Teacher from one of the Author's Models.

teachers and pupils: (a) 21 two-tube sets, (b) 4 three-tube sets, (c) 7 four-tube sets. All of these have proved to be entirely satisfactory and we are glad to say that we have verified all of the original claims made by Dr. Roberts and the "Radio Broadcast." This is the one instance thus far in our experience in radio construction in which the actual performance of a set in question considerably surpasses the original claims made for it. Figure 25 gives a record of an evening's performance with a two-tube set which was built into a "lighthouse" cabinet like that

shown in Figure 9. Figure 26 is the record of the operation of a Roberts' two-tube set located in the vicinity of the new Research Laboratory of the Radio Corporation of America, located near the southeast corner of Van Cortlandt Park, New York City.

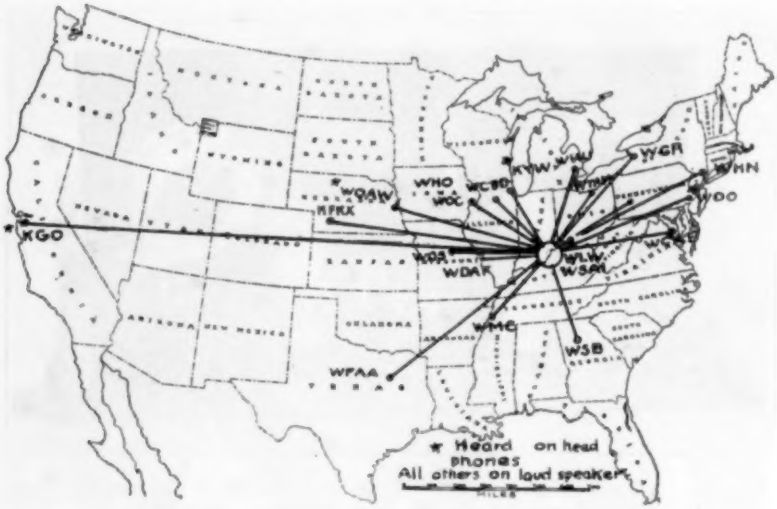


FIG. 25. A VACATION EVENING IN AUGUST, 1924, WITH A ROBERTS' TWO-TUBE RECEIVER. LOG BY EARL R. GLENN.

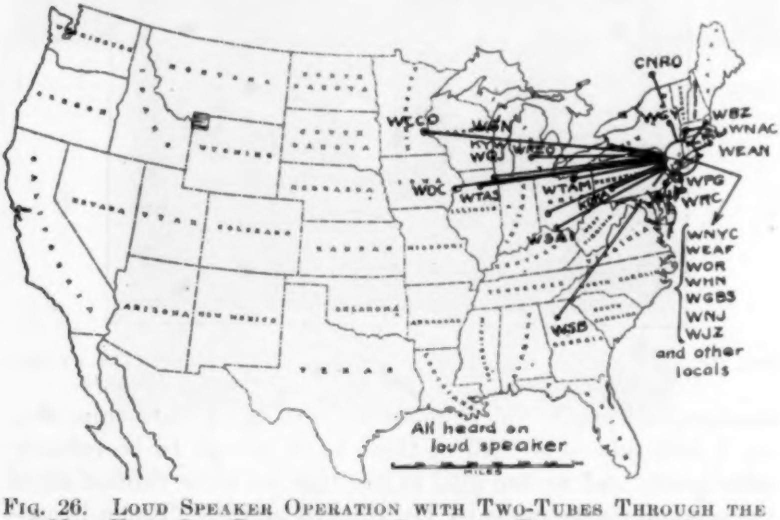


FIG. 26. LOUD SPEAKER OPERATION WITH TWO-TUBES THROUGH THE NEW YORK CITY BROADCASTING STATIONS. FEBRUARY 21, 1924. LOG BY EARL R. GLENN.

Figure 27 records the performance of a Roberts' two-tube receiver which was constructed by Mr. F. A. Riedel in the

Greely High School, Greely, Colorado, and fortunately this record is made for the same evening as that shown in figure 26.

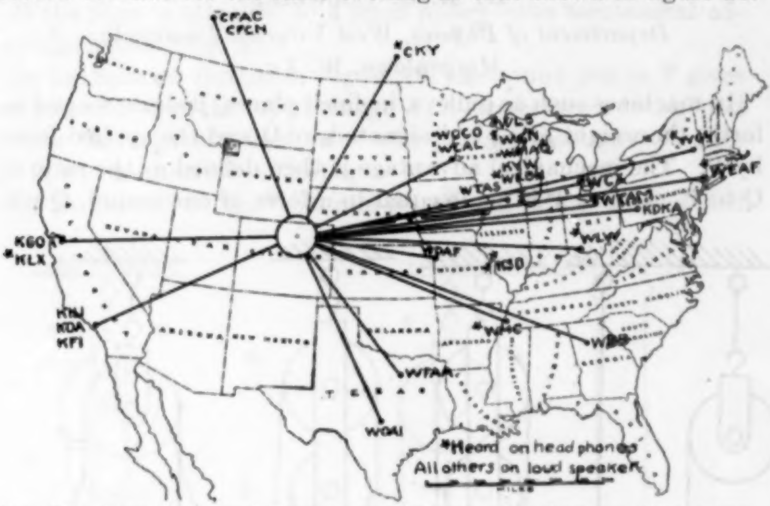
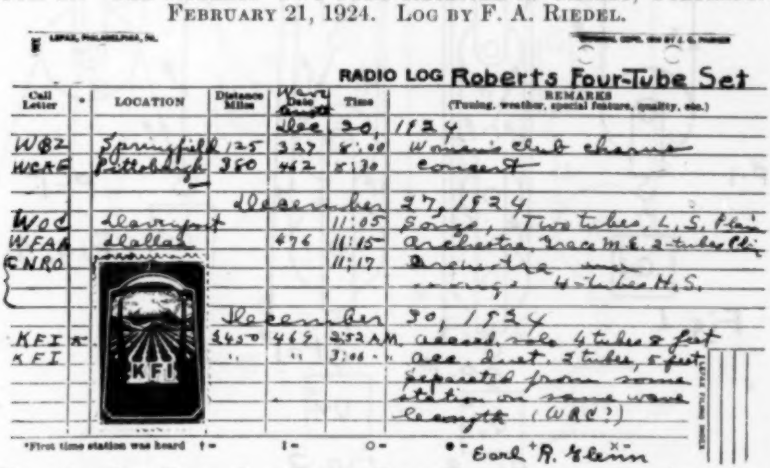


Fig. 27. The Roberts' Two-Tube Receiver in Greely, Colorado. February 21, 1924. Log by F. A. Riedel.



RADIO LOG Roberts Four-Tube Set

Call Letter	*	LOCATION	Distance Miles	Wave Length	Time	REMARKS (Tuning, weather, special feature, quality, etc.)
				Dec.	20,	1924
WBZ		Springfield	125	337	8:00	Woman's club chorus
WCAE		Pittsburgh	380	462	8:30	concert
		December				27, 1924
WOC		Davenport			11:05	Songs, Two tubes, L. S. Plain
WFAA		Dallas		476	11:15	orchestra, trace M.E. 2-tubes Clear
CNRO					11:17	Orchestra [illegible]
						[illegible] 4-tubes H.S.
		December				30, 1924
KFI	x		3450	469	2:52 A.M.	accord. solo 4 tubes 8 feet
KFI			"	"	3:06 "	acc. duet. 2 tubes, 5 feet
						separated from some
						station on same wave
						length (WRC?)

*First time station was heard † = ‡ = ○ = ● = Earl R. Glenn × =

Fig. 28. Our Prize Log Page. From New York to Los Angeles, California, with Two Tubes and Loud Speaker. We Had never Doubted Dr. Roberts' Original Report but now We have Verified it.

We have traced briefly some of our experiences in radio construction, with the hope that many beginners, especially in schools, may save time and money in more or less useless experimentation through which a number of us have had to go in order to arrive at a satisfactory radio receiver. We have used Roberts' receivers a year now, and as subsequent articles will show, this circuit has opened up a new line of work with great possibilities in school science and industrial arts.

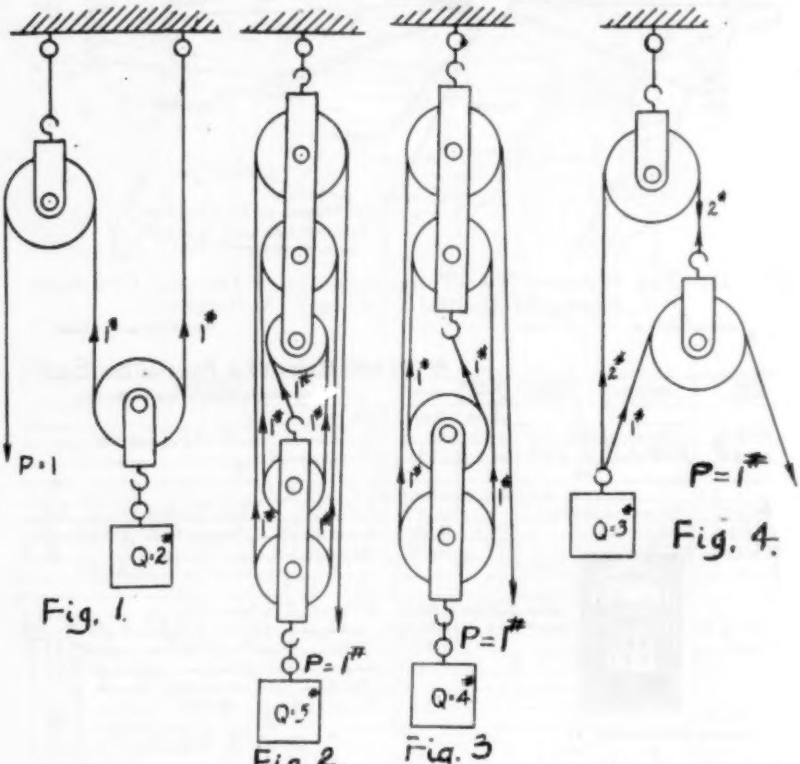
(Parts 2 and 3 to follow)

AN EASY METHOD FOR FINDING THE MECHANICAL ADVANTAGE OF PULLEY SYSTEMS.[1]

By R. C. Colwell,

Department of Physics, West Virginia University, Morgantown, W. Va.

In machines such as pulleys, inclined planes, jackscrews and so forth, the weight lifted is designated by Q and the applied force by P. The mechanical advantage is then defined as the ratio of Q to P. If now P is made equal to a force of one pound, Q will



be the mechanical advantage. Hence to find the mechanical advantage apply a force of one pound to the system and calculate Q. This method is particularly suitable for pulley combinations. For instance, in a system with one fixed and one movable pulley, a one-pound pull in the rope at A causes the tension to be applied on *both* sides of the pulley B. Hence, Q=2 (Mechanical Advantage) (Fig. 1).

In a system of three fixed and two movable pulleys (five ropes

[1]This method was suggested to me by Mr. Lee Fullmer, mechanician of the Physics Department, West Virginia University.

with the end attached to a movable pulley) there are five pulls on Q or the mechanical advantage is *five* (Fig. 2).

If the rope 's attached to a fixed pulley—the mechanical advantage is *four* (Fig. 3).

In the Spanish Burton of Figure 4 a one-pound pull in P gives one pound at Q in the rope through A; it also causes a two-pound pull in the rope attached to A and passing through B, hence Q = 3, the mechanical advantage.

In the Burton of figure 5 a one-pound pull in P is transmitted

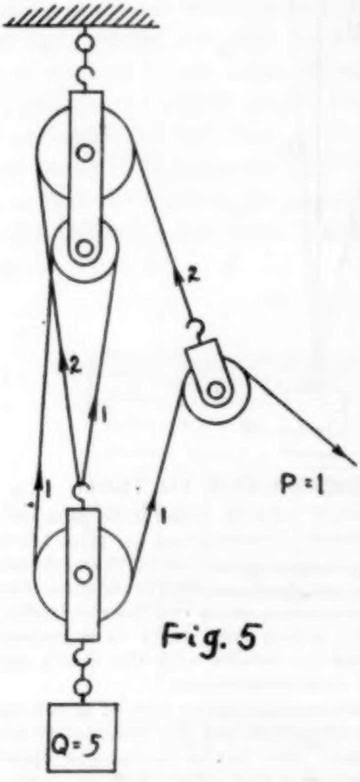


Fig. 5

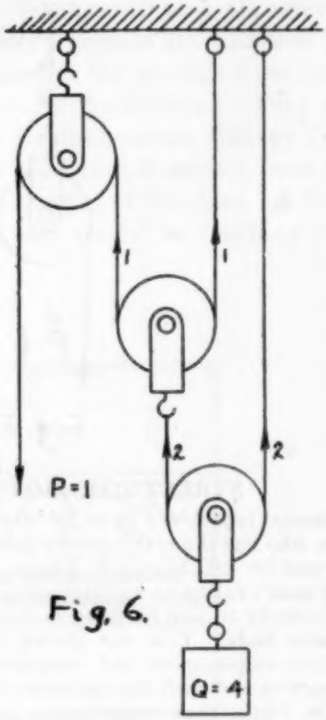


Fig. 6.

along its rope to make 3 pounds at Q. Also the pulley A gives 2 pounds so that Q = 5 is the mechanical advantage.

In the pulley system, Figure 6, each pulley hangs from the fixed block by a separate string. A pull of one pound in P makes a pull of 4 at Q, hence the mechanical advantage is *four*.

When each cord is attached to the weight the mechanical advantage is seven (Fig. 7).

The method outlined above is applicable to any arrangement of pulleys no matter how complicated.

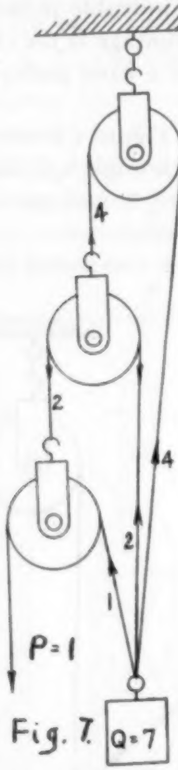


Fig. 7

STREET CAR MOTORMEN PUT TO TEST.

Special laboratory tests by which it may be possible to pick out the man who has the makings of a safe and efficient street car pilot are being devised by Dr. Morris S. Viteles, of the University of Pennsylvania.

A man's rating on an intelligence test does not always indicate whether he is likely to lose his head in emergencies, or to run his car badly, Dr. Viteles finds. This was shown by giving such tests to motormen in regular employment and comparing the results with the men's records in service and with the opinions of their supervisors.

Dr. Viteles then worked out a motorman selection test by which signals are given on a piece of mechanical apparatus and the prospective motorman responds with the same muscles that would be used in operating a trolley car. This apparatus measures the safety factors, such as a man's capacity to learn, his ability to keep his attention steadily on his job, and to act quickly in emergencies so as to avoid accidents. To test an applicant's general ability and courtesy, the psychologist devised a set of questions such as: "If an intoxicated man was annoying the passengers in your car would you: 1. Put him off the car? 2. Pay no attention to him? 3. Turn him over to the nearest officer? or 4. Report to the train dispatcher?"

The problem of the alert and capable motorman is also being studied by use of elaborate testing machines in a new laboratory in Paris. A feature of the French laboratory is a realistic reproduction of a street car, in which the motorman's reaction speed and control are put to the test.

A YEAR IN BIOLOGY III.

By Harry A. Cunningham,
The University of Kansas, Lawrence, Kansas.

Charting Accumulated Evidence.

As the course progressed, a considerable amount of data, bearing upon each student, was accumulated. It is important to get all of this data for each student upon a separate chart. For teaching purposes, it is also important that the data be in such form that the student or his parents can easily understand it. For teaching purposes, we want to avoid such terms as: I. Q., achievement age, mental age, etc. If Mary's parents are told that her rate of reading is just about the same as the average score made by pupils in the eighth grade, they can understand. They can also understand if told that, on the Ruch-Cossman, Biology Test, Mary ranks in the quarter of the class that is second from the top or that she ranks in the lowest quarter of the class. A chart like the following has been found very useful for teaching purposes:

Chart No. 1.

THE USE OF TESTS.

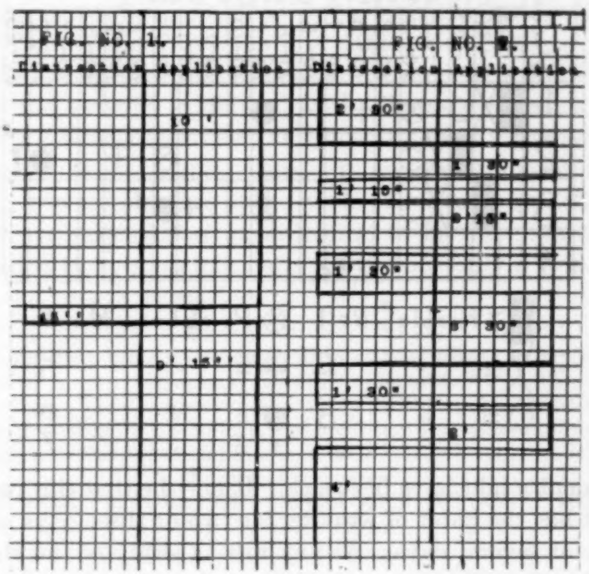
Enough has been shown to indicate that the main use made of tests in the course was for teaching purposes. Tests to find out the study abilities were given to find what training was needed and the training was based upon the things revealed by the tests. The *preparation* step at the beginning of a unit might well be considered a test because it revealed to the teacher what the mental state of the class was in regard to the unit that was being approached, and indicated to the instructor just what needed to be included in the unit. The *presentation test* was given to see if the teaching in the *presentation* had really registered. If it had not, the unit was re-presented until the entire class got the point. All through the period of *assimilation* various assimilation tests were given, not for the purpose of grading but for the purpose of finding out how to proceed further in working through the assimilation period. At the end of the *assimilation* period, or when it was felt that assimilation had taken place in most cases, an assimilation test was given covering the entire unit. The results from this test determined finally those who were ready to pass on to another unit and those who must do some more work upon the old unit. No pupil passed on to another unit until his assimilation test revealed that assimilation of the unit under consideration was complete. A very great variety of tests was used for this testing. Teachers must become acquainted with the many different forms of tests and use the form that will likely best enable him to find out what he wants to know. True-false tests and best answer tests are particularly vauable when the aim is to test understanding, separate and detached from composition ability. The important attitude for a teacher to take here is that tests are primarily for teaching purposes rather than for grading purposes.

SUSTAINED APPLICATION.

During the periods of directed study, an admirable opportunity was presented for giving training in sustained application. It is impossible to give this training unless some form of directed study is adopted. During the *assimilation periods* those who did not have the ability to give sustained attention were soon identified. These students were then watched, at times when they were unconscious of it, and pictures of how they worked were made on *The Chicago Sustained Application Profile Sheet.*

Figure No. 1 is the profile of a good student. The periods of application are long. There is no evident need of training in sus-

tained application in this case. Figure No. 2, however, tells a different story. In this case the attention is poor both in quantity and quality. Two or three pictures of this kind will be effective, at individual conference time, in showing a student just how he worked at such and such a time. This mode of procedure is very effective because the student realizes that the teacher is not talking in general terms but that he really has the facts.



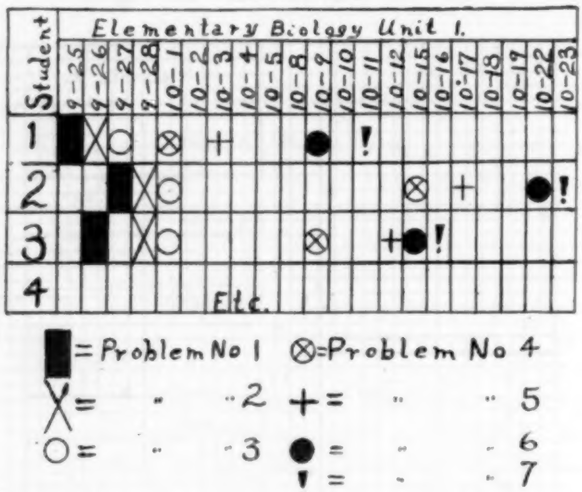
DEFINITE DIRECTIONS FOR ASSIMILATION PERIOD.

After the first two steps, *preparation and presentation*, in our teaching technique had been completed, definite mimeographed directions were given for the work during the *period of assimilation*. The unit was very often broken up into sub-problems and these sub-problems afforded the definite tasks for the *assimilation* period. Much valuable light upon the methods of work and the rate of work of different members of the class can be obtained by noting the accuracy, the rapidity, and the regularity with which these problems are solved. A record of these problems was kept on a sheet similar to the sample below.

In actual practice such charts as the one represented above are often made upon large sheets of graph paper and hung up in the room where the class can observe it. In the place of the characters used in the chart to represent the different problems, different colors may be used. Much valuable information can

be gotten from the study of such a chart. It will be noted that student No. 1 went through the problems with regularity and rapidity. In the case of student No. 2, however, it is evident that something was wrong between problems three and four. There are many possibilities that might explain the gap. A difficulty might have been encountered in problem four. Again

CHART No. 2.



the student might have been sick. It may be that this particular student has the habit of working for two or three days and then loafing for several days. At any rate, a study of the chart will show that something happened to student 2 between problems three and four. The teacher should find the trouble and remedy it. The idea for such charts as I have just described came to me from Mr. Wilbur Beauchamp of the University of Chicago.

There are serious dangers connected with this method of dividing a unit up into a number of problems. It is very easy to get too many problems. This will make the unit drag out over too long a period and tend to make the class lose interest. It is very easy for the teacher to introduce a number of problems that are really not necessary for a thorough understanding of the unit. In such a situation, the students will get lost in the maze of problem solving and lose sight of the unit entirely. When this occurs, we are employing no better technique than that of *lesson assigning and lesson learning.* As time goes on our tendency is to cut down the number of problems to two or three. These are made somewhat more inclusive, so that, in the solution of one or two of them, the main points of the unit are covered. After

the solution of these two or three problems an assimilation test may indicate that some in the class have attained mastery. If such is the case there is no need of having them spend more time in problem solving on that unit. Further work may then be provided for those who have not yet attained mastery.

LABORATORY WORK.

Under our technique laboratory work first makes its appearance during the *presentation* in the form of lecture demonstration. Presentations may often be made more helpful and more interesting if lecture demonstrations are introduced. During the *assimilation* period some laboratory work is done by lecture demonstration and some by individual work. Laboratory work is done whenever it is needed to help in the solution of a problem or to make some phase of a unit clearer. In no case is laboratory work segregated to certain days of the week. In no case are laboratory experiments assigned, as experiments, to be done, written up, and handed in by a certain date. It is done only if it is needed and at the time it is needed.

Three hundred and fifty foremen of industrial plants in Pennsylvania are enrolled in the engineering extension department of Pennsylvania State College. This has proved one of the most popular forms of industrial service offered by the college, and eight new foremen-training classes, in as many different industrial plants, have recently been established.

NEW WORLD MADE FOR PLANTS AT BOYCE THOMPSON INSTITUTE.

How plants respond to strange conditions never found in nature, such as daylight arbitrarily set at anything from zero to twenty-four hours a day, carbon dioxid ten times as concentrated as it is in normal air, and atmospheric moisture held anywhere that the manipulators want it, was told in an illustrated discussion before the American Association for the Advancement of Science by John M. Arthur of the Boyce Thompson Institution, Yonkers, N. Y.

One lot of plants was given ten times the normal amount of carbon dioxid and at the same time had its daylight period lengthened six hours with powerful electric lights. Red clover plants in this lot blossomed and produced a good crop of hay in 38 days, when under ordinary agricultural conditions two years would have been required for the same results. Spring wheat, barley and oats in the same group produced taller plants, yielding larger crops of both grain and straw, than control plants under normal conditions.

A second series of plants was given light for 24 hours a day, but no extra carbon dioxid. These did little better than the control plants, and on the whole not nearly as well as those that were given the extra gas. Apparently plants need a rest, for a tomato plant subjected to continuous light treatment finally died. A second tomato plant, given 19 hours of light and 5 hours' rest, survived and grew slowly, while a third, with 7 hours' rest each night, bore fruit.

With its facilities for complete and accurate control of all conditions affecting plant life, the Boyce Thompson Institute plans a long and extensive campaign of research into the fundamental problems of plant physiology.

SOME NEW AND OLD TYPES OF PHYSICS TESTS.[1]

By N. Henry Black,
Graduate School of Education, Harvard University, Cambridge, Mass.

C. E. E. B. Examinations.

First, let me call your attention to the valuable work of the College Entrance Examination Board during the past twenty-five years in making better and better physics examinations. Their tests are prepared by a committee of college and school teachers and revised by a committee of college teachers and school executives. The answer books are read, graded, and often reread by a group of college and school teachers. Thus you see that these examinations are a *coöperative* enterprise. If you are not familiar with them may I urge you to study them carefully, for they represent the best of their type.[2]

Laboratory Examinations.

Second, let me briefly describe the Laboratory Examinations in Physics which have been conducted in Cambridge in June and September for more than thirty years. They count equally with the written examination for admission to Harvard college. But just what is such an examination? Briefly, it consists in having each student perform three or four experiments which he has already done in his school laboratory in the course of the year. When he has finished an experiment, he is quizzed about his work, his calculations, his equations, and about the significance of his results. Usually the candidate is questioned by three or four different teachers, each of whom records in code his estimate of the student's ability not only to do physical experiments but also to think about physical phenomena. This last year we conducted these laboratory examinations every day for two weeks in June and for one week in September, and the whole staff of the Physics Department took part. We also had the help of four of the most experienced physics teachers in the neighboring schools. When I was myself a schoolmaster, I used to find such examinations given in my own laboratory of great value in helping the student to review his experimental work. If you are so situated that you cannot run off such a laboratory examination, try giving a written test based entirely on the laboratory experiments. You will find (if your experience is anything like mine) that it will prove a

[1]This is a summary of a talk given before the Physics Section of the Central Association of Science and Mathematics Teachers at Chicago on November 27, 1925.
[2]The C. E. E. B. Examination Questions for the last 25 years can be bought of Ginn and Company.

mighty stimulus toward more thoughtful work in the laboratory.

Comprehensive Examinations.

Today, however, I want especially to call your attention to a new type of physics test, which might be called a comprehensive examination. It was recently prepared by Miss Frances M. Burlingame, a student of mine in the Harvard Graduate School of Education. The preliminary edition is in two forms, A and B, and each consists of sixty exercises based on the whole range of topics usually covered in a first-year course.

The material used in these tests was selected with unusual care and the tests themselves were compiled according to the modern practice in educational measurements. More details about the sources of the material and the method of constructing the tests will be found in the Manual of Directions.[3] In these tests we have used three types of questions: *true-false, completion,* and *selection of the best result.*

Purpose of These Tests.

There are three problems connected with the making of these tests which we want your help in solving: First, which of these types of questions above mentioned correlates most closely with the teacher's judgment of the student's achievement? Second, how closely do the results of these 35-minute tests agree with the school record? Third, how closely do these tests, Form A and Form B, agree with each other? In short, we need to determine some standard norms for these tests. I have come all the way from Cambridge to Chicago for the purpose of interesting some of the physics teachers here in trying them on their own classes. The copies will cost you nothing, and we shall do all the drudgery of scoring them. But we do want to get them tried out exactly according to our directions in various sorts of high schools in various sections of the country. We are especially anxious to get in touch with schools which have the semester plan and which have classes that complete their first-year course in physics at mid-years. Since these tests cover the whole year's work, they should be given only when the class has nearly completed the year's work in physics. We should much prefer to hear from schools which are willing to give both Form A and Form B to the same class for purposes of comparison.

Uses of Such Tests.

In closing I would venture to remind you of some of the possi-

[3]Sample copies of this test together with a manual of directions will be sent to any physics teacher who applies to Professor N. Henry Black, Jefferson Physical Laboratory, Harvard University, Cambridge, Mass.

ble uses or advantages of such tests as these: 1. They cover the whole field in a short time. 2. They are objective; that is, the scoring of the test is not affected by the reader's state of mind. 3. They are prepared with much greater care than any one teacher could be expected to expend on a routine examination. 4. When standards have been determined for these tests, we shall have another yardstick, crude to be sure, with which to measure the effectiveness of our teaching.

Other Tests.

I am, of course, not unaware that this sort of thing has been tried before, notably by Glenn and Obourn in their series of physics tests. But I am also sure that there is need for numbers of physics tests. For instance, I may sometime be able to tell you about several other new types, now in process of construction, which aim to measure the student's ability to apply his physics knowledge to common phenomena; or which try to determine his keenness in finding out what is wrong with pictures of apparatus which has purposely been set up askew. And finally, we surely need a diagnostic test which will determine for us what ails the students who find physics so very, very hard.

The most encouraging thing about these new types of tests is that the students like them. There must then be some good in them. If any teacher here would like to coöperate with us on this enterprise, let him write to me at once. Thank you.

SOME LABORATORY PRACTICES IN BIOLOGY IN SECONDARY SCHOOLS.

By Mary Elizabeth Pape,

Senior High School, Marietta, Ohio.

Last spring a study was completed in which the laboratory practices in Biology in secondary schools were considered. The main points of this study were: first, what problems or exercises were done in the Biology course and which were done as teacher demonstration and which ones by individual pupils; second, what method did the teacher recommend for various exercises which she did not use then; and third, the teacher's evaluation of the various exercises. Besides these main points, many other items of interest were obtained. The questionnaire method was used to obtain the information.

Probably the most outstanding fact, with the exception of the slight predominance of individual method, was the great variation in the exercises done by teacher demonstration and by individual

pupils. That is the partial answer to the first aim of the investigation, what exercises were done in the Biology course and which ones were done as teacher demonstrations and which ones by individual pupils. It was obvious that the laboratory equipment and apparatus have been dominant factors in determining the exercises done and the method. "Type" exercises ranked rather high in usage. By "types" are meant such exercises as "Structure of a simple flower," "Cells and cell structure," "Osmosis," "Dicotyledonous seeds (external)," "Dicotyledonous seeds (internal)," "Structure of roots," etc., that is those that were unified into a central topic from which others might be developed. There was to a marked degree a coordination between the nature of the exercises used and their application to the environment. This was shown by the extensive use of those exercises dealing with plants and insects in the fruit growing and agricultural districts and the predominance of exercises on hygiene and community sanitation and civic betterment in the cities. Field trips and excursions were mentioned by several as constituting part of their laboratory work. It was noted that in many schools sex education was taught in laboratory by means of those exercises on reproduction in plants and animals.

The exercises used in many instances were of the kind requiring very little apparatus, evidently indicating the lack of sufficient equipment for the performing of the more complicated ones. In four schools there was no laboratory work given. This was explained by the large number of Biology classes preventing laboratory work, by the lack of equipment, and lack of adequate space for laboratory work.

As a whole, the individual method slightly predominated over the teacher demonstration method. The exercises done by this method were such that in many instances they could not have been done conveniently otherwise. Some examples of this kind were "Paramoecium," "Monocotyledonous seeds (external)," "Monocotyledonous seeds (internal)," "Structure of a simple flower," "External features of a frog," "Arthropods," "Daily calorie requirement," "Structure of fruits," etc. This also shows from the nature of the exercises performed that elaborate and costly materials and apparatus were not used in most of the schools. Most of such materials and specimens could have been collected by the pupils on field trips. Environmental problems or projects dealing with the improvement of the community and home were given emphasis.

In the study made by Cooprider[1] on Biology laboratory methods, he found that the demonstration method with oral instructions was more efficient than with written instructions; but with individual work the written instructions were more efficient. He did not find any appreciable difference between the work done by either method. He recommended the individual method with written instructions if the laboratory work is to be maintained in the course, but the comment of these teachers suggests their approval of the demonstration method for many exercises.

Some of the exercises performed by teacher demonstration were of the kind that would have required an enormous amount of apparatus if performed by the individual pupil. Most of those that are included in physics were done by teacher demonstration. The technique involved in many demonstrations must have influenced the method.

The answer to the second aim, what method would the teacher employ if she were using various exercises which she was not then using, indicates that the teacher demonstration method would prevail slightly over the individual method. This also shows that much equipment and apparatus would have been necessary and may be the reason for not including them in the course. Cooprider,[2] advocates that the demonstration method should be used in preference to the individual method if laboratories are inadequately equipped for individual work. That geographical, industrial, and economic factors decidedly influenced this question was shown by personal replies.

The third aim, the teacher's evaluation of the various exercises on the basis of being essential, desirable, or non-essential, may be summed up in this manner: the majority of teachers considered most of them essential. "The structure of a simple flower," "Adaptations in a fish," "Adaptations of an insect for pollination," etc. were not considered as non-essential by any teacher. "Transpiration pull" was rated as non-essential by forty-three per cent of the teachers, while the "Pocket germinator" and "Test for acetanilid in patent medicines" were next in rating as non-essential by thirty-seven per cent. The percentage of the exercises rated as non-essential by a majority of teachers was low in the rest of the exercises.

The resultant data, taken as a whole, indicate that the general

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[1]Cooprider, J. L. "Laboratory Methods in High School Science," SCHOOL SCIENCE AND MATHEMATICS, 23:526-530 (June, 1923).

[2]Cooprider, J. L., "Laboratory Methods in High School Science," SCHOOL SCIENCE AND MATHEMATICS, 23:526-530 (June, 1923).

practice in Biology laboratory work agrees with the objectives of the Biological sciences as stated in the "Reorganization of Science in Secondary Schools."[3]

In conclusion, it might be said there were wide variations as to exercises used and teachers' evaluations of the exercises, but the individual method stands out as being only slightly more popular than the demonstration method. This method is just the opposite of that reported in general science according to the study made by Meier,[4] who found the demonstration method practiced more than the individual method. The resultant method of this investigation agrees with the statements of Parker[5] and Cooprider.[6] Parker says: "Historically the extensive adoption of the individual laboratory work in high schools is a matter of relatively recent development." In his conclusions, Cooprider says: "If our purpose in laboratory exercises is to meet immediate needs, it would seem that oral instruction should be given preference to written instruction. . . . On the other hand, if we wish our students to retain laboratory work, it appears from this study that demonstration work should be given with oral instructions and the individual work with written directions. Also, individual work should be given in preference to the demonstration."

The difference in laboratory method between general science and Biology may be accounted for by the different type of materials used in Biological laboratory work from that of general science, by the sequential place of Biology in the science curriculum, and also by the content of subject matter of Biology.

[3]"Reorganization of Science in Secondary Schools," Bulletin 1920, No. 26. Bureau of Education, Washington, D. C.

[4]Meier, Lois, "Current Practices in the Teaching of Science in the Seventh and Eighth Grades," General Science Quarterly, 9:1-7 (November, 1924).

[5]Parker, Samuel Chester, "Methods of Teaching in High Schools," Ginn and Company. Boston, 1915. Page 450.

[6]Cooprider, J. L., "Laboratory Methods in High School Science," School Science and Mathematics, 23:526-530 (June, 1923).

FIRST OUTDOOR ELECTRIC LIGHTING HALF CENTURY AGO.

At Cornell University, the first institution in the country to teach electrical engineering, the first outdoor electric lighting plant was installed in 1875, according to Prof. Frederick Bedell, four years before Edison made the first practical incandescent light. This was on the original Cornell campus, the illuminating being supplied by two arc lights. The current was furnished from a dynamo built by Prof. W. A. Anthony and Prof. G. S. Moler, who is still a member of the faculty. Although it was recently used as a shop motor, this generator, said to be the first ever constructed in the western hemisphere, is still in good condition, and is preserved in Rockefeller Hall. —*Science Service.*

PROBLEM SOLVING—APPLIED TO FIELD WORK IN BIOLOGY.

By Walter P. Porter,

Supervisor of Biological Science, Athens, Ohio, High School.

A field trip is a type of laboratory work in which the students are permitted to study plants and animals in their natural habitat. Too often this is taken to mean a general survey of nature rather than a specific study of a particular problem. The purpose of a trip in many cases is clear only to the teacher and fills no need of the class other than a desire to get out of the classroom for an hour. This type of work is a waste of time. Students should go into the field only to solve a problem and return with the solution of that problem. Too often they return with nothing but a collection of burrs on their clothing and a nebular idea of the beauties of nature.

The field trip should evolve out of a felt need or problem on the part of the students rather than of the teacher. It should end with the solution of the problem. The teacher should be on the alert for indication of difficulties to be solved; as when a student says, "I wonder how that bird builds that kind of a nest," or "If that plant produces so many seeds, why wouldn't they soon cover the earth?" This is an awakened interest, and if given the proper encouragement will lead to a very desirable form of field work, the aim of which will be to give the answer to the questions and lead to further investigation. The work in the classroom should raise the problems, the work in the field should solve them.

When a problem arises the teacher should plan a field trip, bearing in mind that it is a valuable learning situation and as such should be planned as carefully as any other lesson. Before going on any trip it is well to keep in mind three things:

1. Value or relation to present classroom activities.
2. Class interested in a definite problem and feeling that the field trip would aid in solving it.
3. Finding the things looked for and using them when found, in the solution of a definite problem.

When a field trip is to be undertaken these things should be clear in the mind of both students and teacher. (a) Purpose of the trip, (b) How to attack the problem, (c) Where to go to study. The teacher should prepare by,

1. Going over the ground beforehand to make sure that the class will find what they are looking for.
2. Assembling all equipment needed.
3. Outlining procedure and supplying each member of the class with all necessary materials.

It is essential that the ground be covered beforehand by the teacher, as the failure to do this often leads to waste of time. Too often teachers get into the field and are forced to say, "I was sure we would find that plant here but I guess we will have to let it go." Carrying cans and boxes may be a nuisance, but it is the only way to be sure of collecting any specimens that are to be brought back to the laboratory. If one relies on finding tin cans and empty boxes, disappointment will probably be the result.

Prepare a definite outline of the things to be observed and a method for carrying out the trip. Give each student a copy. It is best to have it large enough that all notes may be taken on the outline sheet. The following procedure would be a fair example of the method of conducting a field trip.

Let us suppose that in the study of weeds the question comes up, "Why do we have so many weeds and how can we get rid of them"? (a) It has a direct relation to the classroom work. (b) The class is interested enough to ask the question. (c) The field trip should be conducted to solve it.

Go over the gound to be covered and list the weeds found. Supply each student with a list. Give each weed a number as this will avoid writing in the field and aid in identification later. The list should not contain more than fifty plants.

PLANT LIST.

1. Sweet Clover.	13. Jewel weed.
2. Rag weed.	14. Mustard.
3. Giant rag weed.	15. Bouncing Bet.
4. Pig-weed.—Red root.	16. Butter and eggs.
5. Jamestown or Jimson weed.	17. Evening Primrose.
6. Great mullein.	18. Poison ivy.
7. Milk weed.	19. Colts tail.
8. Teasel.	20. Dandelion.
9. Canadian thistle.	21. Lambs quarters.
10. Plantain (2 kinds).	22. Cockle-burr.
11. Dock (3 kinds).	23. Queen Ann's lace.
12. Spanish needles.	24. Black nightshade.
25. Chickory.	

Get as many small vials (2 drahm) as there are plants on the checking list. Collect specimens of the seed of each weed. Take some good book for the identification of weeds, hand lenses, envelopes, cord, and some larger containers (6 oz.). The list numbers of the weeds may be written on the corks of the vials.

GENERAL DIRECTIONS FOR THE TRIP.

Date..................................

Why do we have so many weeds and how can we exterminate them?

We are going out (give exact route) to study the distribution of weed seeds. You will find many provisions of nature for distribution and dispersal of the seeds. When you find one, check it on the list and be sure that the class has a sample of it. Write down whether there are few or many seeds and how they are carried. Put the list number on the cork of the vial. Example: 22—Cockle Burr, a burr, stickers, animals—many.

See how many ways you can find for distributing seeds. Make a sketch of seed pods.

If you would like to know more about any plant you find, label it with the number and look it up when you return. Collect anything that may be of use in future study.

This should be mimeographed if possible; if not, write it out on the blackboard that all may copy it.

Let the students discover the types of seeds and find the weeds on the list. They may not know all of them but by discussion among the group they will be able to identify many of them. If they are interested they will bring unknown specimens to the teacher for identification. A common bad practice is for the teacher to find a plant and lecture to those who can crowd near enough to hear, while those who cannot hear waste time in throwing burrs and getting into mischief. The lecture method should only be used when it is apparent that it will solve a difficulty for the majority of the group. If students show no interest in collecting material, do not require them to do it, because if they are not interested in collecting material for use in the classroom, the trip is a failure and forcing them to collect it is a waste of energy.

The trip should be so planned that a definite amount of time is used and that the group is busy the entire time. Never change the plan after starting out! Carry it through! If the students make discoveries that interest the group, make those discoveries a basis for additional trips. When sufficient data have been secured to solve the problem, return to the classroom. Do not waste time rambling.

The last step is the part most often neglected—the use of the data and material collected. This may be placed under the following heads:

1. Organization of the data.
2. Applying it to the problem and forming conclusions.
3. Discussion by the group.
4. Checking up by the teacher to determine value of the trip.

If the trip has been a success the group will have discovered these things:

1. Weeds produce many seeds.
2. Plants grow close together and some are crowded out.
3. Some seeds are found in conditions unfavorable to growth, such as poor soil.
4. Weather conditions affect growth of weeds.
5. They are cut down by man.
6. The seeds are eaten, and plants are destroyed by animals.

With these things in mind the group should have no difficulty in reaching a solution of the problem. An outline for discussion such as this would help:

Why do we have so many weeds and how may they be exterminated?
1. What is a weed?
2. Why do you find so many dandelions in your lawn?
3. What kinds of weeds do you find in your garden and how did they get there?
4. Why are weeds a nuisance?
5. How are weed seeds distributed? Discuss efficiency of each method.
6. Has the city any right to force a man to cut his weeds if he does not want to?
7. Discuss methods of exterminating weeds.

During this discussion such questions as prodigality, survival of the fittest, gardening, Public Health, good citizenship, use of chemicals in the war on weeds, will arise and students should be encouraged to do further study and investigation on some topic of particular interest. One student with a mathematical turn of mind might figure out the number of cockle burrs placed end to end it would take to reach to the moon. He would be much surprised to find that at the end of the sixth generation, providing all seeds grew and reproduced a like number of individuals, there would be enough to reach to the moon and back and make a path around the earth one-half mile wide. Such problems have little scientific value but they help students to realize the number of seeds produced by plants and create interest in the work.

The check-up should follow the discussion. A good method of conducting a test over such work is a "limited answer" test. To illustrate:

1. Any plant growing naturally where you do not want it to grow is a..................
2. Four types of seeds or pods are: 2.................., 3.................., 4.................., 5..................

Five common weeds are: 6.................., 7.................., 8.................., 9.................., 10..................

The tendency of a plant to produce many seeds is called: 11..................

The following conditions affect the growth of weeds: 12.................., 13.................., 14.................., 15.................., 16..................

Three types of winged weeds are: 17.................., 18.................., 19..................

Three types of burrs are: 20.................., 21.................., 22..................

Three methods of exterminating weeds are: 23.................., 24.................., 25..................

If there are no facilities for mimeographing this test, copy the question on the blackboard and have each student number paper from one to wenty-five. Answer the questions with one word for each blank.

To illustrate answers to test above:

1. Weed.	4. Explosive.	7. Cockle burr.	10. Mustard.
2. Winged.	5. Rattling.	8. Jewel weed.	etc.
3. Burrs.	6. Milkweed.	9. Evening Primrose.	

The test may be varied with drawings for identification, thereby offering the desirable feature of novelty. This test should be marked by the students in the group as soon as all are finished, because a test is primarily a teaching device and not merely an instrument for ascertaining marks.

Our aim in all field work should be to help the students solve problems by studying the subject in its natural environment. It should have a direct relation to the work of the classroom. It should aid the students in solving a definite problem. It should always be conducted with the understanding that it is a learning situation from which the students should profit more than the teacher.

WHAT IS A HOLE?

By Hanor A. Webb,

George Peabody College for Teachers, Nashville, Tenn.

A Question Is Asked.

Not many weeks ago I received this letter:

L...................., Tennessee, May 26, 19....

Dear Professor:

I would be glad to have you give me a thourough explanation of what a hole is, that is wheather or not a hole is visible or invisible.

B.................S...................

From its appearance, it was obviously a sincere letter. The writer was evidently thoughtful, and seeking knowledge. He was not densely ignorant, for there are only two mis-spelled words in the correspondence; a record that compares favorably with the letter the college graduate writes, if we believe the stories of the business men to whom they make application for positions.

The request was probably to settle an argument. The writer very carefully presents both sides in setting forth his desires, without giving any emphasis whatever to one or the other, which might influence the judge—myself. He states, first, his general

inquiry, then the specific details upon which the definition hinges. His diction is unusually clear and direct, without circumlocution or irrelevant comment. The question is not a hypothetical one, with assumptions and contingencies. He may be a school teacher, but if so, he is unspoiled. He undoubtedly is a student, whether he has ever done more inside school walls than learn to write.

An Answer Needed.

So instead of considering this as the letter of a crank or a fool, I was impressed with its qualities, and set myself to give as clear and definite an answer. In reply I wrote—

But really, who am I that I may claim to know the model answer to this question! Perhaps it is one upon which there should be a consensus of judgment. In fact, I would like to know the clearest way of telling what a hole is, and whether it is visible or invisible. It is worth something to me to find out—worth something to many of us, perhaps.

I Offer a Reward.

For the best letter of not more than 200 words answering the question, "What is a hole?" I will give a valuable prize, probably a new or renewed subscription to School Science and Mathematics for a year. For the second best, I will give a new or renewed subscription to General Science Quarterly for a year. If there are others the Editor of this magazine wishes to print, a reward will be made for each.

Send your answers directly to me. An interesting article, "What is an Area?" by A. B. Frizell, in School Science and Mathematics 14:579-582, (1914) is a good model except in length.

What is a hole, anyhow?

DOCTORS' CHARGES CHANGE WITH MEDICAL PROGRESS.

What should a doctor charge his patient? This is a question that was brought up before the American Association for the Advancement of Science meeting recently by Dr. Michael M. Davis of the United Hospital Fund of New York.

Since the advent of the specialist, the increase in the importance of the laboratory analysis, X-rays and therapeutic services, radical changes have come about in medical fees, Dr. Davis said. In the old days when most physicians did practically the same work, the fees charged were, so to speak, fixed by custom and were fairly uniform.

At the present time fees in cities, and to a less extent in the country, vary from $1.00 a visit to the office of a country practitioner, to $10,000 for a major operation by a surgeon of national reputation. Other costs besides doctors' fees have arisen, such as expenditures for laboratory and X-ray tests, nursing, and hospital charges.

THE CROSS-WORD PUZZLE IN BOTANY.

BY ORAN RABER,
University of Arizona, Tucson.

An opportunist has been described as a man who finds the wolf at the door and appears next morning in a fur coat. In this day and age the teacher who can subtract a grain of comfort from the fads and whims which detract from concentration on school work must be such an opportunist. Automobiles, radio, bridge, and mah jong have not been much assistance to the teacher of botany, and now we have with us the renaissance of the cross-word puzzle. Can the puzzles be made to serve us better than the fads of yester year?

First we must decide whether there is any good in cross-word puzzles. Decidedly, yes. Above everything they teach the dictionary and reference book habit. In these days of new reading methods when the alphabet is *passe* there are many students who aren't quite sure whether to look for *Indian* before or after *indigo*, and cross-word puzzles *do* require a use of the dictionary.

They increase the vocabulary. That alone is an advantage not to be passed over lightly. The knowledge of synonyms is one of the marks of an educated man and he who is poor in words is poor indeed.

Puzzles also make for clear thinking. A puzzle must be solved in only one way. There is generally but one answer and the usual slipshod methods can not be followed here. A five-letter crossword is not very different from a four-letter one, but what a difference it makes in a puzzle!

A fourth advantage lies in spelling. Words used in puzzles must be accurately spelled. English plurals can not be placed on Latin singulars. But what use to extoll or excuse the puzzle? It is here; let us make the most of it.

Puzzles vary in their difficulty with (1) the complexity of the pattern, (2) the familiarity of the words used, and (3) the clearness and preciseness of the synonomy. These three factors determine whether a given puzzle is easy or difficult. The simplest kind has a simple pattern of a few familiar words in which the synonomy is very exact.

The most difficult puzzles consist of many uncommon words in a complex pattern with a vague synonomy. Between these extremes lie the majority of puzzles.

But however good an exercise puzzle solving may be, the making of the puzzle is a much better one. The following graded botanical puzzles were made by my class in elementary botany at the University of Arizona. They are passed on to others interested in botany for what good they may derive from them. Be assured, however, that only when those equally good have been made, will the maximum of benefit be derived. It is easy enough to make "just puzzles" but when all the words have to be taken from a certain restricted field, the problem becomes more complicated. But I must not discourage you.

In the following pattern eighteen puzzles are given. This is the simplest type possible with only four words:

TYPE I.

Puzzle No.	*Horizontal.*	*Vertical.*
1.	1. A common fungus disease.	1. The stalk of a moss capsule.
	2. Where buds are found.	3. Cultivate; work the soil.
2.	1. Where gemmae are found.	1. A kind of "moss."
	2. Part of the vascular tissue.	3. A disease of corn.
3.	1. A prefix meaning large.	1. One of the Bryophytes.
	2. Clusters of spores or sporangia.	3. Sacs.
4.	1. Neither tree nor shrub.	1. An epidermal growth.
	2. A bad disease of cereals.	3. A root vegetable.
5.	1. An important grass.	1. Strobilus.
	2. Buds of potatoes.	3. A type of dry fruit (plural).
6.	1. A vegetative organ.	1. A slender marsh plant.
	2. A conducting vessel.	3. A group of grass plants.
7.	1. Pulverised rock.	1. Young onion bulbs.
	2. A vegetative organ.	3. 1 horizontal with much humus.
8.	1. A common pomaceous fruit.	1. A common gymnosperm.
	2. Groups of corn fruits.	3. Medullary ——.
9.	1. Not wanted in lumber.	1. A brown alga.
	2. A type of fleshy fruit.	3. Neither herb nor shrub.
10.	1. A textile plant.	1. What a parasite lives on.
	2. A woody perennial.	3. A gymnosperm.
11.	1. The cortex.	1. Aids to cross pollination.
	2. A type of soil.	3. The cause of "bird's eye."
12.	1. Prefix meaning below.	1. Necessary for growth.
	2. Ends.	3. Plants of the genus, Avena.
13.	1. What leaves do when in need of water.	1. Xylem.
	2. A tropical fruit.	3. The commercial source of "1".
14.	1. Common name for *Vicia*.	1. Phloem.
	2. A Weed.	3. Where the leaf is borne.
15.	1. A phycomycete.	1. In evolution next above the Hepaticae.
	2. Needed by asparagus.	3. A conducting vessel.
16.	1. Center of the stem.	1. Connect tracheids.
	2. A ripened ovule.	3. A dense cluster of sessile or nearly sessile flowers on a very short axis or receptacle.
17.	1. End of the spindle.	1. Prefix meaning many.

	2. A southern root vegetable (plural).	3. A tree (plural).
18.	1. Angle between leaf and stem.	1. The maple genus.
	2. A cereal.	3. An attribute of organisms.

A variation of this type equally simple is the following of which only one example is given.

I. 2.

Horizontal.	*Vertical.*
1. Necessary for a graft.	3. A fungus disease.
2. Where crop plants are grown (plu.).	4. A type of fleshy fruit.

Type II.

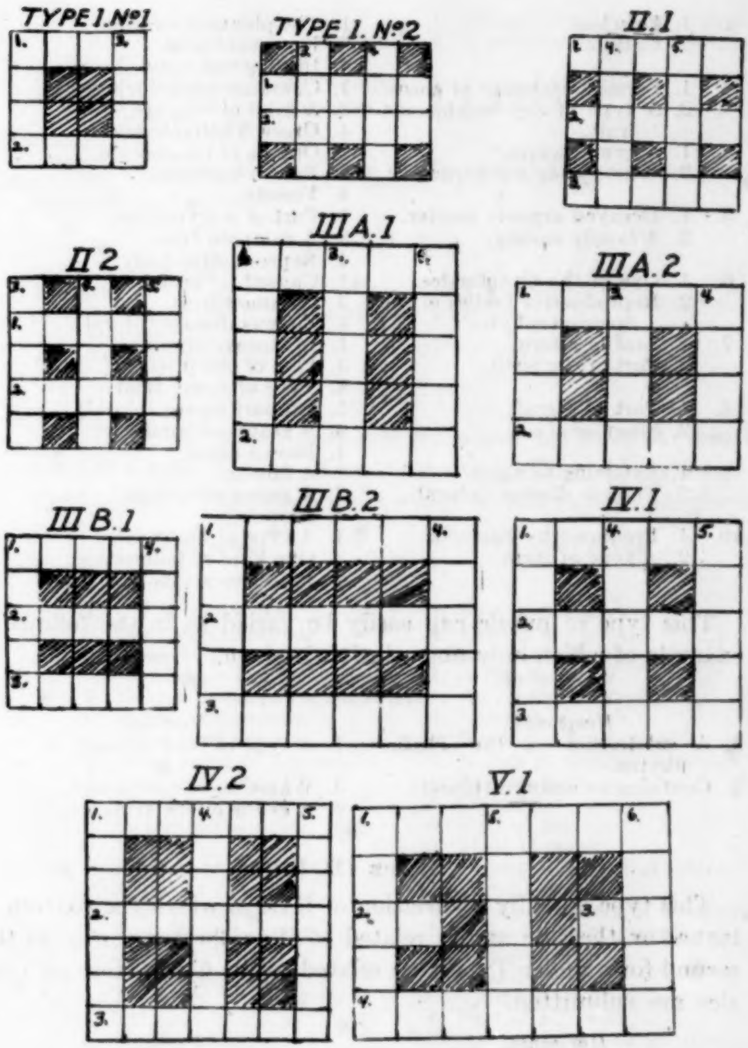
In this type five words are employed in the following pattern: Not only are more words used but in many cases they are less common which makes the puzzle still more difficult. Seven puzzles are given.

Puzzle No.	*Horizontal.*	*Vertical.*
1.	1. A male gamete.	4. An organism not an animal.
	2. Necessary for germination.	5. The genus of rhubarb.
	3. Vegetative organs.	
2.	1. Part of a cone.	
	2. Green Thallophytes.	4. Aids to locomotion.
	3. A genus of sedges.	5. What deciduous trees do in spring.
3.	1. Thallophytes without chlorophyll.	4. An inflorescence in which the peduncles or pedicels spring from the same point.
	2. A genus of Gymnosperms.	
	3. Thallophytes with chlorophyll.	5. Spore bearing tissue of the Gasteromycetes.
4.	1. One of the floral envelopes.	4. A type of dry indehiscent fruit.
	2. A part of "1."	5. A Saccharomycete.
	3. Seed coat.	
5.	1. One of the pieces into which a capsule splits.	4. A catkin.
		5. A thin membrane of young Agarics.
	2. The units of structure.	
	3. Supporting and conducting organs.	
6.	1. Growth produced by insects.	
	2. Part of a pine pollen grain.	4. An organic acid.
	3. Organs of absorption.	5. Required for photosynthesis.
7.	1. Decomposition products.	
	2. A sac.	4. Mid-rib.
	3. Produced in respiration.	5. A type of fleshy fruit.

A slight variation of this type is the accompanying pattern of which one example only is given.

II. 2.

Horizontal.	*Vertical.*
1. A genus of the Umbelliferae.	3. A sac.
2. A genus of lichens.	4. A subject for botanical study.
	5. A genus of the Rosaceae.



Type III A.

This type of puzzle also contains five words and is of the same difficulty as the ones just given. The chief difference is in the pattern which contains only two groups of blots. In this class ten puzzles are submitted.

Puzzle No.	*Horizontal.*	*Vertical.*
1.	1. Seed-coat.	1. Neither herbs nor shrubs.
	2. Group of spores or sporangia.	3. A product of photosynthesis.
		4. A sac.

2.	1. Fern leaf. 2. Catkin.	1. The plants of a region. 3. Immature seed. 4. Having two cotyledons.
3.	1. Permits exchange of gases. 2. A type of dry indehiscent fruit.	1. Common name for Cassia. 3. A kind of "orange." 4. Green Thallophytes.
4.	1. A gymnosperm. 2. Where buds are borne.	1. Organs of locomotion. 3. Round bacteria. 4. Vessels.
5.	1. Decayed organic matter. 2. A family ending.	1. Part of a mycelium. 3. A common tree. 4. Reproductive body.
6.	1. One of the Graminales. 2. Reproductive bodies of the Spermatophytes.	1. Caused by insects. 3. Common fruit. 4. Fungus disease (plural).
7.	1. Leaf of a fern. 2. Part of the pistil.	1. In storage organs. 3. Part of the pistil. 4. Type of fleshy fruit.
8.	1. Part of a graft. 2. Singular of sori.	1. Support leaves (plural). 3. A group of families. 4. Brown algae.
9.	1. Referring to algae. 2. Fungus disease (plural).	1. A flower. 3. A group of species. 4. Branches.
10.	1. Produced by bacteria. 2. A type of stem.	1. A type of fleshy fruit. 3. One kind of pollination. 4. Produces alcohol.

This type of puzzle can easily be varied as in the following example of which only one solution is given.

III. A 2.

Horizontal.	*Vertical.*
1. A subdivision of the Thallophytes.	1. A type of food (plural).
2. Contains an embryo (plural).	3. Where leaves are found.
	4. A genus of the Iridaceae.

Type III B.

This type is really a variation of IIIA in which the pattern is turned on the side and is related to it in the same way as the second form under Type II is related to the first. Here six puzzles are submitted.

	Horizontal,	*Vertical.*
1.	1. An early Roman botanist. 2. Seed-coat. 3. Necessary for photosynthesis.	1. Part of the corolla. 4. Used in baking.
2.	1. Strobili. 2. Bearing leaves. 3. Beginning of the gametophyte.	1. Morphological units. 4. Part of the pistil.
3.	1. Tropical monocots. 2. A Vermont dicot. 3. Below the stigma.	1. Fleshy fruit (plural). 4. Cells in the phloem.
4.	1. The navel of a seed. 2. Suffix meaning leaf. 3. A seed appendage (plural).	1. A fungus filament. 4. Saprophytes.

5.	1. An aid to pollination.	1. An organism not an animal.
	2. A common pomaceous fruit.	4. A relative of the onion (plural).
	3. Woody perennials.	
6.	1. Between species and family.	1. Produced by insects.
	2. Prefix meaning colorless.	4. Teleuto ——.
	3. Cells in the bast.	

This type can also be very easily varied as the accompanying example indicates.

III B, 2.

Horizontal.	*Vertical.*
1. Bark.	1. A gymnosperm.
2. A megasporophyll of the spermatophytes.	4. Wood.
3. A free swimming alga.	

Type IV.

In Type IV which demands six words we have the prettiest kind of simple puzzle. Here three words of equal length cross at right angles. Thirteen puzzles which fit this pattern are given.

Puzzle No.	*Horizontal.*	*Vertical.*
1.	1. Opening in a leaf.	1. Part of the calyx.
	2. Botanical organism.	4. Part of the pistil.
	3. A method of propagation.	5. One of the Compositae.
2.	1. Named by Hooke (plural).	1. A gymnosperm.
	2. Help in locomotion.	4. An oleaceous shrub.
	3. Result of bacteria.	5. Habitat of ferns.
3.	1. Vegetative organs.	1. Reproductive bodies.
	2. Outer layer of a spore.	4. Genus in the heath family.
	3. Part of a cone.	5. Phloem cells.
4.	1. Disease of wheat (plural).	1. Dock.
	2. In the genus Acer.	4. Part of calyx.
	3. Wood.	5. Male Gamete.
5.	1. Type of fruit (plural).	1. Object of botanical interest.
	2. A garden flower.	4. Part of corolla.
	3. Cultivates the soil.	5. Group of spores or sporangia.
6.	1. Divisions on a stem.	1. In archegonia (plural).
	2. Desert plants.	4. Decomposition.
	3. Part of pistil.	5. Found on "2."
7.	1. Produced by bacteria.	1. Tulipa.
	2. Syringa.	4. Part of a bundle.
	3. False fruits.	5. Sperms pass through them.
8.	1. Betula.	1. Root vegetables.
	2. Sambucus.	4. Root.
	3. Male and female.	5. Plants not woody.
9.	1. Fungus diseases.	1. Stem.
	2. Dry indehiscent fruit.	4. Kind of spore.
	3. Found in wood (plural).	5. Produced by spermatophytes.
10.	1. Fleshy underground stem.	1. Produced by pollen grains.
	2. Seeds used for food.	4. Lamina.
	3. Vegetative organs.	5. Fungi.
11.	1. What sperm does with egg.	1. Fern leaf.
	2. A bulb.	4. Feather grass.
	3. Whitlow grass.	5. Cassia.
12.	1. A gymnosperm.	1. Juniperus.
	2. Class of angiosperms.	4. The genus of "1" horizontal.

3. Garden flower (plural). | 5. Tropical fruit (plural).
13. 1. Fruit with stony endocarp. | 1. Below average size.
2. Provincial English name for the white poplar. | 4. Type of flower cluster.
3. The India butter tree. | 5. Synonym of the genus Kobresia.

A common variation of this type contains four squares in a blot. Only one example is given.

IV. 2.

Horizontal.
1. Trimming.
2. Water hemlock (plural).
3. Basts.

Vertical.
1. Female sex organ of Nemalion.
4. Box-elder.
5. Sex cells.

And now just to show what can be done in the way of making cross-word puzzles by elementary botany students, the following ten puzzles are given. I shall call these Type V.

V. 1.

Horizontal.
1. Sex cells.
2. Chemical symbol for a fungicide.
3. Chemical symbol for an element found in the grasses.
4. Not fertile.

Vertical.
1. The most common monocot.
5. Sambucus.
6. Part of an Agaricus sporophore.

V. 2.

Horizontal.
1. A stonewort.
2. Alkaloid obtained from certain species of Anhalonium.
3. Source of mescal.

Vertical.
1. Tropical flower much used in gardens.
4. Tropical fruit (plural).
5. Pimpinella.

V. 3.

Horizontal.
1. Aids to spore distribution.
2. Center of a drupe.
3. A southern root vegetable.
4. A common weed.
5. Group of corn fruits.
6. Members of a genus.

Vertical.
1. Organic catalysers.
7. A kind of food.
8. End.
9. Ascus.
10. Forest tree.
11. Part of the pistil (plural).

V. 4.

Horizontal.
1. Reproductive organs.
2. Dry indehiscent fruit.
3. Eggs.
4. Potato bud.
5. One of Ophelia's flowers.
6. Part of the pistil (plural).

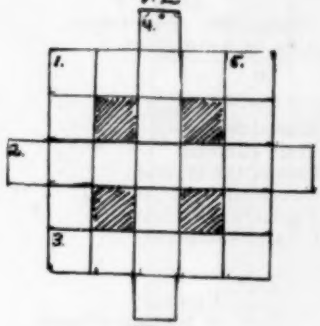
Vertical.
1. Dactyls.
7. Plant of the genus Avena.
8. Prefix meaning upon or upper.
9. Prefix meaning outer.
5. Distilled from fermented molasses.
10. Microsporophylls.

V. 5.

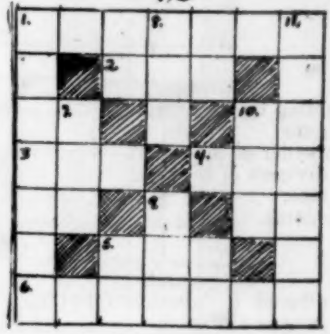
Horizontal.
1. Prefix meaning alike or similar.
2. A tree (poetic).
3. To start development or growth.
4. A tree.
5. A hardy cereal.

Vertical.
6. Female gamete.
7. Group of spores of sporangia.
8. Requisite for 3 horizontal.
9. Environment of ferns.
10. A class of algae.

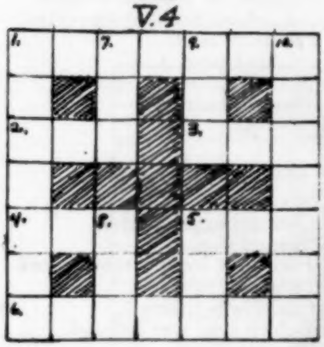
V.2



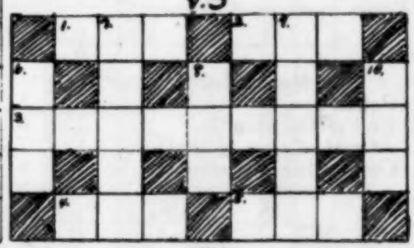
V.3



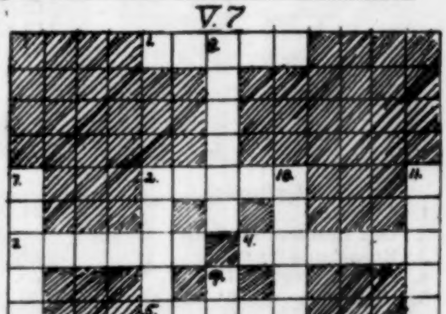
V.4



V.5



V.7



V.6

V. 6.

Horizontal.

1. Between two nodes.
2. Red root.
3. Morphological unit.
4. A microorganism.

Vertical.

5. Type of flower cluster.
6. Where 1 horizontal is found.
7. Spore containers.
8. A flower.
9. Rounded leaf segment.
10. Found on under side of a frond.

11. Central line of an organ.
12. Aids to locomotion.

V. 7.

Horizontal.

1. Studied by botanists.
2. Organs.
3. An order of monocots.
4. A division of biology.
5. A tree.
6. Phloems.

Vertical.

7. A seed-fruit.
2. Male gamete.
8. Part of the stamen.
9. Common fruit (plural).
10. Reproductive body.
11. Part of the pistil.

V. 8.

Horizontal.

1. Produced by spermatophytes.
2. A fungus stalk.
3. Color body.
4. Black fungi.
5. One of the Cyperaceae.
6. Prefix meaning rotten.

Vertical.

1. Product of photosynthesis.
7. Important Saccharomycetes.
8. Produces seeds.
2. Fission fungi.
9. With Equisetum spores.
10. Young plant.

V. 9.

Horizontal.

1. Pollen sac.
2. End of the spindle.
3. At end of root (plural).
4. Containing nitrogen.

Vertical.

5. Sex cells.
6. Contain eggs (plural).
7. Sugar fungi.
8. Produced from a mother cell.
9. Fats and proteins.
10. Contain 8 (plural).
11. Before coal was formed.
12. Thallophytes.
13. Most important color.
14. In the Primulaceae.
15. Secondary meristem.
16. Diffusion through a semi-permeable membrane.

V. 10.

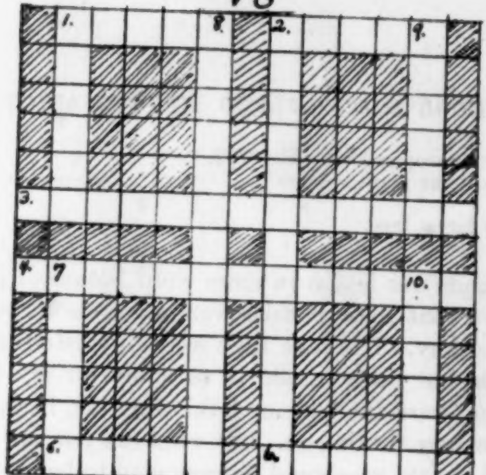
Horizontal.

1. A tree.
2. Dry indehiscent fruit.
3. Rosaceous fruit.
4. Garden vegetable.
5. Character born in chromosomes.
6. Legume.
7. Type of false fruit (plural).
8. West Indian shrub in the genus Erythroxylon.
9. A pine product.
10. Source of oxygen.
11. Mono.
12. Towards the center.
13. Prefix meaning together.
14. Ascus.
15. Forest tree.
16. Supports the leaves.
17. Pertaining to oats.
18. Location of the first plants.
19. Anchorage organ.
20. Type of dry dehiscent fruit.

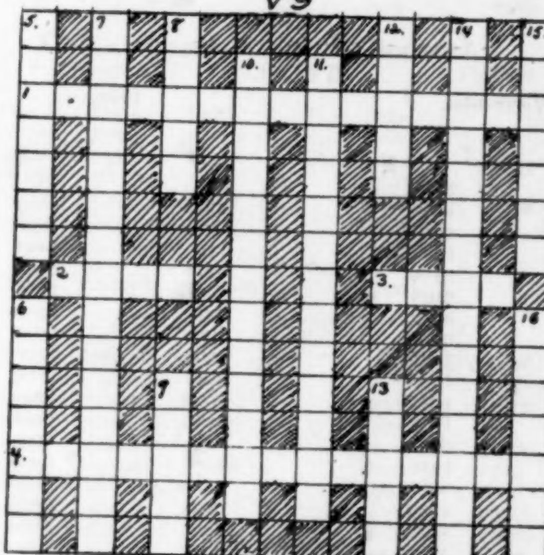
Vertical.

24. ———— of generations.
1. Catkin.
14. Parasite on grasses (plural).
25. A fruit.
26. Carried on by seeds.
27. Bitter compound from root of Asarabacca.
28. Storage stem.
29. From the Caucasus.
30. Possesses two seed leaves.

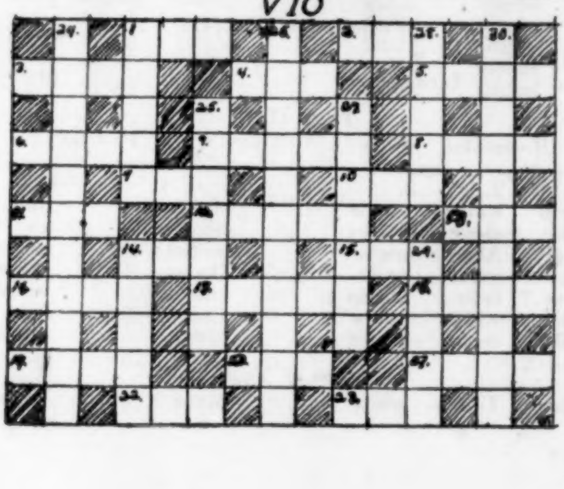
V8



V9



V10



21. Needed for chlorophyll.
22. The source of the plant's energy.
23. A northern forest tree.

And thus ends our lesson in cross word botanical puzzles. I wish to repeat that these puzzles were all made by my class in elementary botany. I believe they were interested in the work or they would not have turned in so many for my inspection. Only a fraction were available and this fraction, in the capacity of editor, I am here turning on. Get what fun you can from them and, needless to say, we should be very glad to hear of your success.

Answers to the Foregoing.

Type I.

Puzzle No.	Horizontal. 1.	Horizontal. 2.	Vertical. 1.	Vertical. 3.
1.	smut	axil	seta	till
2.	cups	bast	club	smut
3.	mega	sori	moss	asci
4.	herb	rust	hair	beet
5.	corn	eyes	cone	nuts
6.	root	duct	reed	tuft
7.	soil	stem	sets	loam
8.	pear	ears	pine	rays
9.	knot	pome	kelp	tree
10.	hemp	tree	host	pine
11.	bark	silt	bees	knot
12.	hypo	tips	heat	oats
13.	wilt	date	wood	tree
14.	bean	tare	bast	node
15.	mold	salt	moss	duct
16.	pith	seed	pits	head
17.	pole	yams	poly	elms
18.	axil	rice	Acer	life

Variation of Type I.

1.	2.	3.	4.
scion	farms	scab	pome

Type II.

Puzzle No.	Horizontal. 1.	Horizontal. 2.	Horizontal. 3.	Vertical. 4.	Vertical. 5.
1.	sperm	water	stems	plant	Rheum
2.	scale	algae	Carex	cilia	leave
3.	fungi	Abies	algae	umbel	gleba
4.	calyx	sepal	testa	akene	yeast
5.	valve	cells	stems	ament	velum
6.	galls	wings	roots	amino	light
7.	acids	ascus	water	costa	drupe

Variation of Type II.

Siler	Usnea	ascus	plant	Dryas

Type III A.

Puzzle No.	Horizontal. 1.	2.	Vertical. 1.	3.	4.
1.	testa	sorus	trees	sugar	ascus
2.	frond	ament	flora	ovule	dicot
3.	stoma	akene	senna	osage	algae
4.	cycad	axils	cilia	cocci	ducts
5.	humus	aceae	hypha	maple	spore
6.	grass	seeds	galls	apple	smuts
7.	frond	style	foods	ovary	drupe
8.	stock	sorus	stems	order	kelps
9.	algal	rusts	aster	genus	limbs
10.	decay	erect	drupe	close	yeast

Variation of III A.

	fungi	seeds	fats	node	Iris

Type III B.

No.	Horizontal. 1.	2.	3.	Vertical. 1.	4.
1.	Pliny	testa	light	petal	yeast
2.	cones	leafy	spore	cells	style
3.	palms	maple	style	pomes	sieve
4.	hilum	phyll	arils	hypha	molds
5.	petal	apple	trees	plant	leeks
6.	genus	leuco	sieve	galls	spore

Variation of III B.

	cortex	carpel	diatom	cycad	xylem

Type IV.

No.	Horizontal. 1.	2.	3.	Vertical. 1.	4.	5.
1.	stoma	plant	layer	sepal	ovary	aster
2.	cells	cilia	decay	cycad	lilac	shady
3.	stems	exine	scale	seeds	Erica	sieve
4.	rusts	maple	xylem	Rumex	sepal	sperm
5.	pepos	aster	tills	plant	petal	sorus
6.	nodes	cacti	style	necks	decay	spine
7.	toxin	lilac	pomes	tulip	xylem	necks
8.	birch	elder	sexes	beets	radix	herbs
9.	smuts	akene	knots	stalk	uredo	seeds
10.	tuber	beans	stems	tubes	blade	rusts
11.	fuses	onion	Draba	frond	Stipa	senna
12.	cycad	dicot	roses	cedar	Cycas	dates
13.	drupe	abbey	fulwa	dwarf	umbel	Elyna

Variation of Type IV.

pruning	Cicutae	phloems	procarp	Negundo	gametes

Type V.

No. 1.

Horizontal.
1. gametes
2. As
3. Si
4. sterile

Vertical.
1. grass
5. elder
6. stipe

No. 2.

Horizontal.
1. Chara

Vertical.
1. Canna

No. 8.

Horizontal.
1. seeds
2. stipe
3. chromatophore
4. Pyrenomycetes
5. sedge
6. sapro

Vertical.
1. starch
7. yeasts
8. spermatophyte
2. schizomycetes
9. elater

2. anhalin
3. Agave

4. bananas
5. anise

No. 3.

Horizontal.

1. elators
2. pit
3. yam
4. rag
5. ear
6. species

Vertical.

1. enzymes
7. fat
8. tip
9. sac
10. oak
11. stigmas

No. 4.

Horizontal.

1. flowers
2. nut
3. ova
4. eye
5. rue
6. stigmas

Vertical.

1. fingers
7. oat
8. epi
9. exo
5. rum
10. stamens

No. 5.

Horizontal.

1. iso
2. asp
3. germinate
4. ash
5. rye

Vertical.

6. egg
7. sorus
8. air
9. shady
10. red

No. 6.

Horizontal.

1. internode
2. beet
3. cell
4. bacterium

Vertical.

5. umbel
6. stem
7. asci
8. rose
9. lobe
10. sori
11. axis
12. cilia.

No. 7.

Horizontal.

1. plant
2. stems
3. Arales
4. botany
5. maple
6. basts

Vertical.

7. grain
2. sperm
8. anther
9. apples
10. spore
11. style.

10. embryo

No. 9

Horizontal.

1. microsporangium
2. pole
3. caps
4. nitrogeniferous

Vertical.

5. gametes
6. oogonia
7. saccharomycetes
8. spore
9. foods
10. spore-capsules
11. prepalaeozoic
12. fungi
13. green
14. Chinese primrose
15. cambium
16. osmosis

No. 10.

Horizontal.

1. ash
2. nut
3. plum
4. pea
5. unit
6. bean
7. pomes
8. eboe
9. tar
10. air
11. one
12. inner
13. sym
14. sac
15. oak
16. stem
17. oaten
18. Eden
19. root
20. pod
21. iron
22. sun
23. fir

Vertical.

24. alternation
1. ament
14. smuts
25. apricot
26. germination
27. asarone
28. tuber
29. kefir
30. dicotyledon

CARNEGIE CORPORATION WILL FOSTER ART INSTRUCTION.

Income from $1,000,000 has been set aside by the Carnegie Corporation to establish a system of scholarships and fellowships in the arts. The purpose is to enable candidates of promise to prepare themselves to be college teachers of art.

In addition $100,000 has been set aside for the purchase of teaching eqiupment for departments of fine arts in colleges and universities.

The trustees of the corporation feel that the number of competent teachers of art is entirely insufficient and that few colleges have either proper equipment for teaching art or the knowledge of how to procure it.—*School Life.*

PROBLEMS IN DIVIDED CIRCUITS.

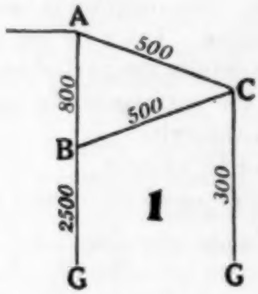
By Wm. F. Rigge,

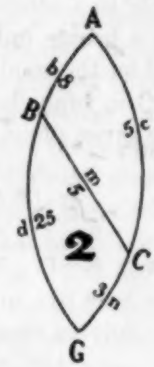
Creighton University, Omaha, Neb.

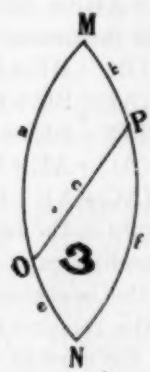
Ten years ago the wire chief of the Western Union Telegraph Company in Omaha asked the writer to solve the following problem:

"A current of 44 milliamperes comes over a telegraph line and is connected as shown in Fig. 1, the annexed numbers being the ohms of resistance in the various branches. It is required to find the effective resistance of the combination, the total voltage, and the volts and amperes in the branches."

SOLUTION: As B is probably at a higher potential than C, current will run from B to C. If this supposition is false, the results will show it. Transforming Fig. 1 into Fig. 2, omitting the *oo* from the resistances, and denoting the voltages in the branches by the small letters, *b, c, d, m, n,* we see that the total voltage







$$V=b+d=c+n=b+m+n$$

and the partial voltages

$$d=m+n \quad \text{and} \quad c=b+m$$

The total current is

$$C=\frac{b}{8}+\frac{c}{5}=\frac{d}{25}+\frac{n}{3}=\frac{d}{25}+\frac{m}{5}+\frac{c}{5}$$

and the partial currents $\frac{b}{8}=\frac{d}{25}+\frac{m}{5}$, and $\frac{n}{3}=\frac{m}{5}+\frac{c}{5}$.

Solving these equations, which are of the first degree, we find the volts V equals 26.407, B equals 11.135, m equals 3.905, n equals 11.367, d equals 15.272, c equals 15.040. The partial currents in milliamperes are in AB 13.92, in AC 30.08, in BC 7.81, in BG 6.11, in CG 37.89. The effective resistance is 600.18 ohms.

It may be of interest to state this problem in general terms. In Fig. 3 let the current flow down from M to N. Let P and O be at unequal potentials. As to which is the higher can be determined only in a concrete case. The diagram is then that of a Wheatstone's bridge out of balance. Let v be the given total voltage, and let the small letters denote the partial and unknown voltages in the branches, and the corresponding capitals, not marked, the given ohms. Then the volts

$$v=a+e=b+f=b+c+e$$

$$f=c+e \qquad a=b+c \quad \text{and the}$$

amperes $\frac{b}{B}=\frac{c}{C}+\frac{f}{F}$ and $\frac{e}{E}=\frac{a}{A}+\frac{c}{C}$

There are here five unknown quantities and five independent equations. Solving them we find

$$a=v\frac{ABC+ABE+ABF+ACF}{ABC+ABE+ABF+ACF+AEF+BEF+BCE+CEF}$$

Calling the denominator D, this may be written

$a=A(BC+BE+BF+CF)\ v/D$, whence
$e=E(AF+BC+BF+CF)\ v/D$,
$c=C(AF-BE)\ v/D$
$b=B(AC+AE+AF+CE)\ v/D$,
$f=F(AC+AE+BE+CE)\ v/D$.

The currents in the branches are readily found by striking out the corresponding capital letters. The total current is the sum of those in the branches a and b, or e and f. The effective resistance is the reciprocal of this total current with v removed. Which way the current flows in OP depends upon the comparative magnitude of AF and BE. If AF=BE, or A:B::E:F, c=O, and there is no current.

It may be noted that the terms of the entire numerator in a, b, e, f, but not in c, constitute half of those in the denominator, so that the fractions have the shape of $m/(m+n)$; that all the terms consist of three factors, each of which is of the first degree, and that all of them except in c, are plus.

In Fig. 4 let another circuit be connected at S and T, and the partial voltages be as indicated. Then the volts

$$v=a+g+e=b+h+f=a+d+f=b+c+e$$

$$h+f=c+e \qquad a+d=b+h$$

$$g+e=d+f \qquad b+c=a+g$$

and the $\quad \dfrac{b}{B}=\dfrac{c}{C}+\dfrac{h}{H} \qquad \dfrac{e}{E}=\dfrac{g}{G}+\dfrac{c}{C}$

amperes $\quad \dfrac{a}{A}=\dfrac{d}{D}+\dfrac{g}{G} \qquad \dfrac{f}{F}=\dfrac{d}{D}+\dfrac{h}{H}$

$$\frac{a}{A}+\frac{b}{B}=\frac{e}{E}+\frac{f}{F}$$

Here there are eight unknown quantities. In eliminating them in anti-alphabetic order, the equation that contained only the one unknown a was found to consist of 223 terms. Several most remarkable and exceptional features then showed themselves. 1. Out of these 223 terms 168, that is, more than three-fourths, cancelled out in pairs. 2. In the fifty-five terms that remained there were two common factors, which were not common to the cancelled ones. 3. Although in the course of the work individual letters had quite generally appeared in the second degree, in the final answer each was in the first degree. 4. The numerator had 18 terms, almost exactly half of those in the denominator, which had 37, and of the numerator 12, or two-thirds, consisted of four plus factors, and 6, or one-third, of three minus ones, while of the denominator 24, or almost exactly two-thirds also, of the terms consisted of four plus factors, but of the remaining 13 there were three factors in each, 5 minus and 8 plus. 5. 15 terms of the numerator were in the denominator also. 6. The factor G does not appear at all. 7. The coefficients are everywhere unity.

The value of a is v times:

$$\frac{\begin{array}{l}\mathrm{ABCD+ABCE+ABCF+ABDE+ABDF+ABDH}\\ \mathrm{+ABEH+ABFH+ACDF+ACDH+ACEH+ACFH}\\ \mathrm{-ABE-ABF-AEH-ADF-ADH-AFH}\end{array}}{\begin{array}{l}\mathrm{ABCD+ABCE+ABCF+ABDE+ABDF+ABDH}\\ \mathrm{+ABEH+ABFH+ACDF+ACDH+ACEH+ACFH}\\ \mathrm{-ABE-ABF-AEH+ACEF+ADEF+ADEH}\end{array}}$$

$$+ADFH+BCDE+BCEF+BDEF+BDEH+BEFH$$
$$+CDEF+CDEH+CEFH-AEF+BCD+BCF$$
$$+BDF+BDH-BEF+BFH+CDF+CDH+CFH.$$

The values of the other unknowns were not found explicitly as in the previous case. They would most probably have shared the former characteristics.

Problems of this kind may be diversified indefinitely. The solution is of course much simpler in a concrete case than in the general one. As the terms are all of the first degree, the problem may be given to students of elementary algebra, and the practical use of their study brought home to them.

CONSOLIDATED SCHOOLS BETTER THAN SMALL SCHOOLS.

Comparing costs and results of education in consolidated and in one-teacher schools in Connecticut shows that 29 per cent of pupils 14 years in one-room schools drop out during the school year, but only 8 per cent in consolidated schools drop out; 41 per cent of those 15 years of age in one-room schools drop out, as compared with 12 per cent in consolidated schools. The percentage of elimination in the fifth, sixth, seventh, and eighth grades of one-teacher schools is approximately twice as great as in the same grades in consolidated schools. Of the teachers in one-teacher schools, 23 per cent have had two years or more of professional training, compared with 49 per cent in consolidated schools; and teachers in consolidated schools have on the average two years more experience than those in one-teacher schools.—*School Life*.

UNIVERSE NOT RUNNING DOWN SAYS CALIFORNIA CHEMIST.

In the course of the Silliman Lectures which Prof. Gilbert N. Lewis of the University of California is giving at Yale University he showed that the acceptance of the Einstein theory of relativity abolished the idea of the older physics that the universe is running down like a clock. According to views hitherto held it seemed that all forms of energy tended to become dissipated and eventually diffused throughout space, and this pointed inevitably to a period in the far future when the universe would come to a standstill forever. Any physical system left to itself would in the long run arrive at this state of run-downness, the degree of which scientists call entropy.

But Professor Lewis pointed out that according to the new geometry of the relativity theory this would not hold true, for the chance that the system would again return to its original state of high potential energy without any outside interference could be calculated, and that this event would necessarily ultimately take place. Thus all phenomena of the physical world are reversible in space-time. Past and future are therefore alike and there is no one-way drift of the universe as a whole.

But in our consciousness time appears to flow in one direction. Our vital processes are irreversible. Life proceeds in one direction from birth to death. Vital phenomena, therefore, do not come under the domain of the physical laws. All irreversible processes result from living things which are cheats in the game being played by physics and chemistry.

Professors Lewis' lecture is regarded as a blow to the mechanism theory which prevailed during the past century and is somewhat in line with the "Creative Evolution" of Henri Bergson.—[*Science Service*.

THE PROBLEM OF SCIENCE TEACHING IN THE SECONDARY SCHOOLS—A COMMENT.

By Elliot R. Downing,
The University of Chicago, School of Education.

In the issue of School Science and Mathematics for November, 1925, (Vol. XXV, pp. 966-975) there is an article by R. A. Millikan which demands comment. With some of Mr. Millikan's major theses I am in hearty agreement, namely that we have scarcely begun to touch the possibilities in science instruction in secondary schools, that among the important things to be considered are the formulation of the courses of study, the determination of methods and the preparation of teachers. I should also concur with him in the desirability of three years of sequential science in high schools.

But that the elements in the problem of secondary school science "are simple and definite and that the mere statement of these elements at once point the way at least to the next steps in their solution" seems to me an optimism born of ignorance. His statement that the successful technique of teaching high school physics and also other high school sciences is now pretty well known, a technique which he claims has been worked out by trial and error is far from the truth. If one had made fifty years ago a similar statement in regard to medicine, namely that the technique of treating diseases had been thoroughly determined by the preceding centuries of the trial and error method, he certainly, in the light of the advances made in the last fifty years by the scientific method, could justly have been accused of rashness. The scientific study of the efficiency of the various types of procedure in the teaching of physics and other sciences has only just begun. The curious thing is that men who are supposed to be saturated with the scientific attitude of mind fail to see that the problems of teaching must be attacked in the same scientific way as the problems of the physical and biological sciences. Surely the trial and error method would not go far in settling the problems on which the present day physicist is at work. Nor can we expect them to be more successful in settling the problems of teaching.

It seems to me that the article in question commits a second breech in the fundamental principles of scientific thinking. It concludes that because contemporaneously there is a decline in the percentage enrollment in the old line sciences in Minnesota

and a gain in general science that the latter is the cause of the former. And yet to conclude that two sets of phenomena which are occurring simultaneously must be related as cause and effect is a characteristic fault of immature thinking. The statistics from Minnesota show similarly that during this period there has been a marked increase in the enrollment in agriculture and domestic science. Would it not be just as reasonable to conclude that these were the offenders against the old line sciences rather than general science? The last figures of the United States Commissioner of Education show that the increase in the percentage enrollment, country over, in general science from 1910 to 1922 is even greater than that quoted for Minnesota. During this same period there has been a marked decline in the enrollment in Latin, English, mathematics. Yet it is hardly possible that the increase in the enrollment in general science is responsible for the decline in these other subjects. Furthermore the decline in the percentage enrollment of the old line sciences began and continued for several years before general science was commonly introduced into the high school curriculum. Such declines not only in the old line sciences but in such subjects as English, Latin, mathematics, are apparently more logically explained by the fact that the number of subjects offered in the high school curriculum has been constantly increasing for a generation, and if a given body of students is subdivided into a continually increasing number of groups the percentage in each is evidently bound to decline.

I am very glad to know that the institution of which Mr. Millikan is head is putting in such a comprehensive program for the training of the teachers of science. I wish all universities might profit by the example. But that the best place to get a teacher of science for secondary schools is "in the great centers of scientific activity in the country; in the graduate schools of science" is not obvious. These graduate schools are not as a rule interested in giving their students a broad foundation in science courses in botany, zoology, chemistry, physics, geology, astronomy, etc., with a view to preparing the student for teaching, but they encourage him to specialize in a single line or in closely related lines with a view to developing him as a potential research worker. More than that such institutions rarely encourage the student to select courses that will acquaint him with the problems of the teaching of science, taking it for granted apparently that all one needs to learn to become a successful teacher is the subject matter that he is going to teach. When one realizes that in

such typical states as Indiana, Michigan, Illinois, Wisconsin, eighty-five per cent of the high schools are four teacher schools it is evident that the science teacher must handle all the science that is taught and likely some other subjects as well. The breadth of preparation required for such teaching is rarely achieved in the great universities. Moreover the high school teacher selected from the graduate schools of science goes out with no appreciation of the objectives of secondary school education, or of the principles of selection of the subject matter, or its organization. He does not realize that he is dealing with a group of pupils that have a psychology peculiarly their own. He teaches as he has been taught at the graduate level. He probably uses a text book, an abridgment of a college text, written by a University professor whose organization of material and presentation is that of the mature scientist and not that of the adolescent pupil. He needs training in the science and art of pedagogy quite as much as in the sciences he is to teach. Modern pedagogy can help him because it solves his teaching problems on a basis of scientific fact.

IT'S COMING.

Although many amateur and professional photographers were inclined to doubt the success of amateur kinematography, it must be evident to the most skeptical that considerable progress is being made to provide good cameras and projectors for amateur use. To be sure, the cost is still a bit high for some; but the day is not far distant when the average amateur photographer will be able to afford a motion-picture camera and use it without too much of a drain on his pocketbook. Still-photography will never be supplanted entirely by the motion-picture; and those who may have fears in that respect should ease their minds at once. However, the motion-picture offers certain opportunities which will add greatly to the pleasure and interest of amateur photography. Then, too, a happy combination of the two is very desirable, even for the average amateur. Certain scenes or events lend themselves to motion; others are better recorded by still-photography. An intelligent use of both will add a new delight to picture-making.

We suggest that our readers keep in close touch with the new equipments that are now being offered; and, wherever possible, obtain a sound working-knowledge of amateur kinematography. This does not imply that the still-camera should be placed on the shelf; but rather that it should be used in happy combination with the motion-picture equipment.—*Photo-Era.*

The platoon, or work-study-play plan of organization, has been adopted by one or more public schools in 101 cities in 33 States. In addition, two private institutions, Carson and Girard Colleges in Pennsylvania, are operated on the platoon plan.

DR. MILLER RECEIVES $1,000 AMERICAN ASSOCIATION PRIZE.

The award of the $1,000 prize of the American Association for the Advancement of Science to Dr. Dayton C. Miller, Case School of Applied Sciences, Cleveland, is a recognition of patience, perservance and service to science as well as an acknowledgment that the results of Dr. Miller's work may require serious changes in the prevalent idea of the way the universe is put together.

The observations made in the course of the ether drift experiments during 1925 consisted of over 100,000 separate readings, a procedure that required Dr. Miller to walk, in the dark, in a small circle, for a total distance of 100 miles while making at very frequent intervals the most delicate measurements possible.

Dr. Miller said in his prize paper: "I think I am not egotistical, but am merely stating a fact when it is remarked that the ether drift observations are the most trying and fatiguing, as regards physical, mental and nervous strain, of any scientific work with which I am acquainted."

That the results reported in the paper that the judges decided was the most notable contribution among the thousand papers of the Kansas City meeting, will have a far-reaching effect on the foundations of physics and astronomy can not be doubted. Dr. Miller repeated the experiment that is fundamental to the Einstein theory and found that the accepted interpretation of the famous Michelson-Morley experiment of 1887 must be reversed. There is an ether drift, the earth does carry along with it through space some of the ether, whereas the Einstein theory was built upon the assumption and the results of the 1887 experiment that showed no such drift.

Either the Einstein theory must be modified to meet the new facts, or if such modification is impossible, it must be scrapped. When Dr. Miller announced preliminary results at the April meeting of the National Academy of Sciences, Einstein acknowledged that the data if confirmed would be a serious blow to his theory in its present mathematical formulation. Physicists do not believe, however, that results of Dr. Miller are impossible of reconciliation with a theory of relativity that is worked out upon new assumptions and facts.

That the earth and the solar system is speeding through space at the rate of 125 miles a second or more, ten times the speed previously suspected, was also revealed by Dr. Miller's experiments. Prof. F. R. Moulton of Chicago during the meeting explained that this high velocity may mean in part that our own stellar galaxy or universe is rushing through the ether. If so, the astronomers may be revising some of their ideas of the composition of the universe.

Dr. Miller began his experiments on ether drift thirty years ago. Soon he will again journey to Mount Wilson to repeat the experiments once more. Such is the method of science; the rewards are an inspiration to mankind.—[*Science Service.*

FOR RATING RURAL SCHOOL-BOARD MEMBERS.

A score card for rating rural school-board members has been devised by the Kansas State Teachers' College at Pittsburg, Kans., following the method of rating pupils, teachers, and superintendents of schools. According to this card, rural school-board members should have at least a good common-school education, own their homes, read a standard farm paper and at least one good magazine, be in favor of spending money for well-trained teachers and of retaining such teachers; they should have expressed themselves as favoring good buildings and equipment; well-prepared and efficient teachers, and good supervision of instruction; and they should possess other desirable qualifications.

SIAMESE STUDENTS NUMEROUS IN AMERICA.

Siamese students are coming in increasing numbers to the United States. The brother of the present king is a graduate of Harvard. The assistant director general of the Royal Siamese Railway and a son of the minister of the interior were educated in this country. Associations have been formed in Siam and in America to promote interest in educational institutions in the United States. As foreign-trained Siamese become available, they are gradually supplanting Europeans employed in the various branches of the Siamese Government.—*School Life.*

BROCKTON GIRLS TRAINED IN STORY TELLING.

A story-telling club as a class activity furnishes to girls in the upper classes of Brockton (Mass.) high school an opportunity for self-expression. At monthly meetings held in the school library a carefully planned program is carried out, and stories appropriate to the season are told. The stories may be learned verbatim or told in the girls' own language. They are rehearsed with a faculty supervisor before telling, the aim being to tell a story that will appeal to children of the first to the fifth grade.

The girls are frequently called upon to speak on special occasions in school, and often go out in teams to entertain children in their schoolroom celebrations.

HIGH-SCHOOL STUDY OF LOCAL INDUSTRIES.

A major course in New York City industries, extending over one term and open to all students, is an elective in George Washington high school, New York City. The course was inaugurated last year as an introduction to the study of economics. No textbook is yet available, but use is made of printed information supplied by commercial, building, and trades bodies, slides from the State visual-instruction division, and information furnished by the students themselves.

COUNTRY CLUB AND RESTING PLACE FOR TEACHERS.

Riverbank Farm, on which is a fine old farmhouse overlooking the Charles River, has been donated to the Massachusetts Teachers' Federation. The gift has been formally accepted, and it is expected that the place will be developed into a country club and resting place for teachers. Members of the Federation are contributing $1 each to provide temporarily for the upkeep of the place, which is 21 miles from Boston.

An extensive school building campaign is in progress in a number of counties in Alabama. At present more than 100 buildings, many of them handsome structures of brick or stone, are in process of erection through aid granted by the State Department of Education.

To encourage thrift many savings banks in Czechoslovakia give to each new pupil in the elementary schools a passbook with a beginning credit of 1 krone. The schools of the country celebrate thrift day and impress upon the children that saving insures happiness and that industry and thrift mean prosperity for the individual and for the nation.—[*School Life.*

"Repeaters" in the Goshen, Ind., high school have been reduced about 10 per cent by an effective system of checking up every two weeks children who are threatened with failure in their studies. Teachers and the principal cooperate in the effort to reduce student mortality, and problem cases are given special diagnosis and receive individual attention.

PROBLEM DEPARTMENT.

CONDUCTED BY C. N. MILLS,
Illinois State Normal University.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor, should have the author's name introducing the problem or solution *as on the following pages.*

The Editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to C. N. Mills, Illinois State Normal University, Normal, Ill.

LATE SOLUTIONS.

897. *J. Muray Barbour, Ardmore, Pa.*
898. *J. Murray Barbour, Ardmore, Pa.; Wilford Knobeloch, Charleston, S. C.; Melvin Jacobs, Charleston, S. C.*
899. *J. Murray Barbour, Ardmore, Pa.*
900. *Gus Lambsberg, Jr.*

SOLUTIONS OF PROBLEMS.

876. *Proposed by Nelson L. Roray, Metuchen, N. J.*

Given $2s$, c, and the altitude h upon side c. Solve the triangle; that is derive formulas for the unknown parts.

Solved by Michael Goldberg, Philadelphia, Pa.

Editor. This solution is mentioned in the October, 1925 issue.

Let the sum of the other two sides of the triangle be m. Then $m = 2s-c$. The locus of a point the sum of whose distances from two fixed points is constant is an ellipse. If one recognizes this fact, a simple analytical solution is possible. If the origin of coordinates is the mid-point of the side c, the equation of the ellipse is

$$\frac{x^2}{\left(\frac{m}{2}\right)^2}+\frac{y^2}{\frac{m^2-c^2}{4}} = 1.$$

If this equation is solved simultaneously with $y = h$, the position of the vertex is found from

$$x^2 = \frac{m^2}{4} - \frac{m^2h^2}{m^2-c^2} = \frac{m^2}{4}\left[1-\frac{h^2}{s(s-c)}\right].$$

Hence,

$$a^2 = \left(x+\frac{c}{2}\right)^2+h^2 = x^2+xc+\frac{c^2}{4}+h^2,$$

and

$$b^2 = \left(x-\frac{c}{2}\right)^2+h^2 = x^2-xc+\frac{c^2}{4}+h^2.$$

Using the above value for x gives

$$a = \frac{2s-c}{2}+\frac{c}{2}\sqrt{1-\frac{h^2}{s(s-c)}},$$

and

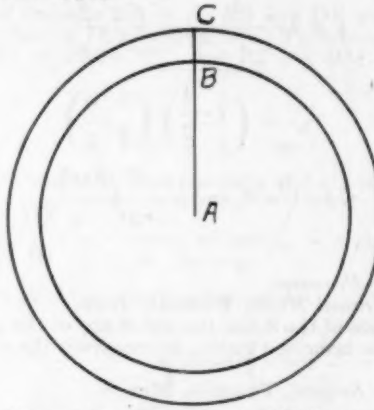
$$b = \frac{2s-c}{2}-\frac{c}{2}\sqrt{1-\frac{h^2}{s(s-c)}}.$$

These values for a and b agree with the values determined by Mr. George Sergent, if the signs of the square root terms are reversed.

901. *Selected.*

"Whoever makes a tour around the earth must necessarily take a larger compass with his head than with his feet. The question is, how much larger."

Solution given by Nicholas Saunderson in his "Elements of Algebra," Cambridge, 1741: Vol. 2, page 579.



Let A represent the center of the earth, AB its semidiameter, BC the traveller's height, AC the semidiameter of the circle described by his head: let also b represent the circumference of the circle whose semidiameter is AB, and c the circumference of the circle whose semidiameter is AC, and c-b will be the difference we are now inquiring into, which may be thus determined.

By the fifth corollary in Art. 347 (The circumferences of all circles are as their diameters or semidiameters) AC is to AB as c is to b; and by division of proportion, BC is to AB as c-b is to b; Let d be the circumference of a circle whose semidiameter is BC, and BC will be to d also as AB to b; Therefore BC is to d as BC is to c-b; therefore $c\text{-}b = d$; that is, *The traveller's head will pass through more space that his feet by the circumference of a circle whose semi-diameter is his own length:* as if the man be 6 feet high, his head will travel further than his heels by 37 feet 8 4-7 inches nearly, and that whether the semidiameter AB be greater or less, or nothing at all.

Also solved by *J. Murray Barbour, Ardmore, Pa.; T. E. N. Eaton, Harper Rowe, Preston Blair, Redlands, Cal.; Michael Goldberg, Philadelphia, Pa.; George Sergent, Tampico, Mexico.*

902. *Proposed by Michael Goldberg, Philadelphia, Pa.*

Show that the fourth power of the infinite continued fraction

$$1+\frac{1}{1+}\,\frac{1}{1+}\,\frac{1}{1+}\,\frac{1}{1+}\cdots\cdots$$

is the infinite continued fraction

$$7-\frac{1}{7-}\,\frac{1}{7-}\,\frac{1}{7-}\,\frac{1}{7-}\cdots\cdots$$

Solved by Leonard Carlitz, Philadelphia, Pa.

Let x represent the first continued fraction and y represent the second continued fraction. Then

$$x = 1+\cfrac{1}{1+\cfrac{1}{1+\cfrac{1}{1+}}} = 1+\frac{1}{x},$$

or,

$$x^2-x-1=0, \text{ and } x=\frac{1}{2}+\frac{\sqrt{5}}{2}.$$

$$x^4=\left(\frac{1}{2}+\frac{\sqrt{5}}{2}\right)^4=\frac{7}{2}+\frac{3\sqrt{5}}{2}.$$

Also

$$y=7-\cfrac{1}{7-\cfrac{1}{7-\cfrac{1}{7-}}}=7-\frac{1}{y},$$

or

$$y^2-7y+1=0, \text{ and } y=\frac{7}{2}+\frac{3\sqrt{5}}{2}.$$

Hence

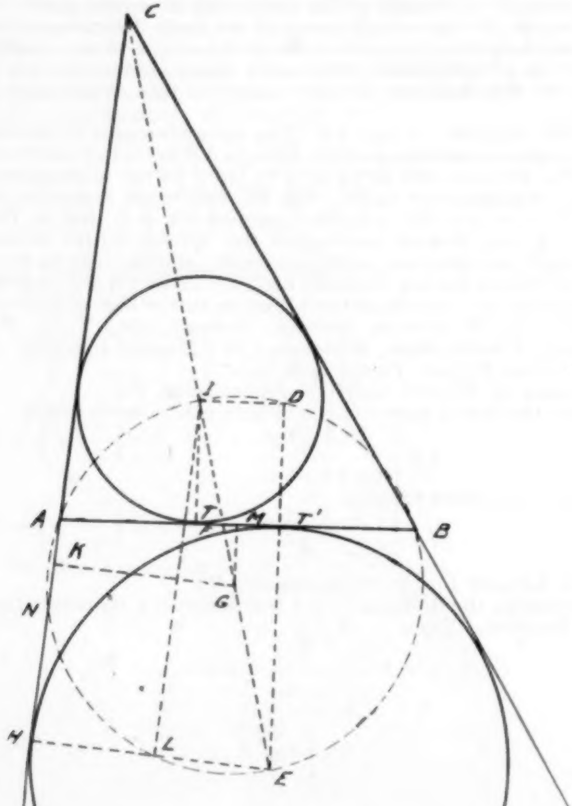
$$y=x^4.$$

Also solved by the *Proposer*.

903. *Proposed by Daniel Kreth, Wellman, Iowa.*

Given the difference of the sides, the difference of the angles at the base, and the radius of the inscribed circle; to construct the triangle and calculate its sides.

I. *Solved by George Sergent, Tampico, Mexico.*



Let d represent the difference of the two sides a and b; D the difference of the two base angles A and B; r the radius of the inscribed circle; r_e the radius of the escribed circle opposite side c.

Construct the right triangle IDE, the right angle at D, with ID $= d$, and (½) D as the opposite acute angle. On DE from D lay off DT$' = r_e$ then T$'$E $= r_c$. From I and E as centers and r and r_c as radii draw the inscribed and the escribed circles. The common interior tangent through T$'$ and the two exterior common tangents determine by their intersection the required triangle ABC.

Computation of the side AB $= c$. AB and DE are intersecting chords of the circle described on IE as a diameter. Therefore AT$'\cdot$BT$'$ = ET$'\cdot$ DT$'$. Since AT$'$ = AM+MT$'$ and BT$'$ = BM−MT$'$, we have the equation

$$\left(\frac{c}{2}+\frac{d}{2}\right)\left(\frac{c}{2}-\frac{d}{2}\right) = r_e r \qquad (1)$$

in which r_e can be computed from the data and $c/2$ is unknown.

From $\cot\dfrac{D}{2} = \dfrac{DE}{DI} = \dfrac{r_e+r}{d}$, we get $r_e = d\cot\dfrac{D}{2} - r$. Substituting this value of r_c in (1) and solving for c gives

$$c = \sqrt{d^2+4r\left(d\cot\frac{D}{2}-r\right)}.$$

Computation of a and b. Since $(a-b)$ is known, $(a+b) = s$ can be taken as unknown. Draw GK and EH perpendicular to CA, and IL parallel to CA. In the similar right triangles CKG and ILE, we have CK $= s/2$, KG $= (1/2)(r_e+r)$, IL = AB $= c$, LE $= (r_c-r)$. Also we have

$$\frac{\frac{1}{2}s}{c} = \frac{\frac{1}{2}(r_e+r)}{r_e-r}, \text{ or } \frac{s}{c} = \frac{r_e+r}{r_e-r}. \quad (2)$$

Since $r_e+r = d\cot\dfrac{D}{2}$, then $r_e-r = d\cot\dfrac{D}{2}-2r$.

The proportion (2) now becomes

$$\frac{s}{c} = \frac{d\cot\frac{D}{2}}{d\cot\frac{D}{2}-2r},$$

whence

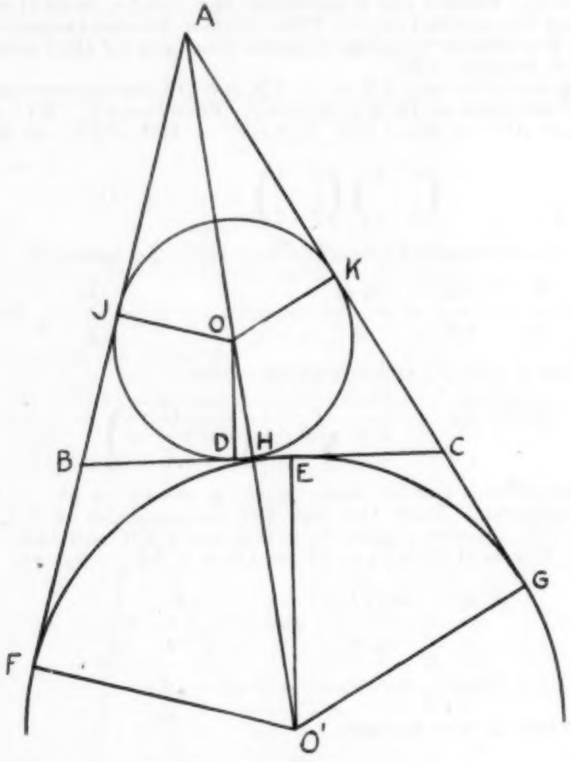
$$s = \frac{c\,d\cot\frac{D}{2}}{d\cot\frac{D}{2}-2r} = \frac{c\,d}{d-2r\tan\frac{D}{2}}.$$

Since c has been determined, s is completely determined in terms of given data. Therefore $a = \frac{1}{2}s+\frac{1}{2}d$, and $b = \frac{1}{2}s-\frac{1}{2}d$.

II. *Solved by Michael Goldberg, Philadelphia, Pa.*

Draw the inscribed circle O and a tangent at D. Find H on the tangent such that DOH $= \frac{1}{2}(B-C)$, and locate point E on the same side of D as H

such that DE = $(b-c)$. Draw EO′ perpendicular to the tangent. Produce OH to meet EO′ in O′. Draw circle with center O′ and radius O′E. Then the common external tangents to the circles and the original tangent form the sides of the required triangle.



Proof. $\angle CHA - \angle BHA = 2\angle DOH$.

$\angle CHA - \angle BOH - (\angle BHA - \angle HAC) = 2\angle DOH$.

Therefore

$\angle B - \angle C = 2\angle DOH$.

Also
$$\begin{aligned} AF + FG &= AB + AC + BF + GC \\ &= AB + AC + BE + CE \\ &= AB + AC + BC = 2s. \end{aligned}$$

Hence $AF = AG = s$.

Also
$$\begin{aligned} BD + BJ &= BC + AB - CD - AJ \\ &= BC + AB - CK - AF \\ &= BC + AB - AC = 2s - 2b. \end{aligned}$$

Hence $BD = BJ = s - b$.

Likewise

$CE = CG = s - b$.

Therefore $BD = CE$, and $(b-c) = AC - AB = AG - GC - (AF - BF)$
$= BF - GC = BE - CE = BD + DE - CE = DE$.

Computation for A, B, and a.

$$OO' = \frac{b-c}{\sin\frac{B-C}{2}}, \text{ and } EO' = \frac{b-c}{\tan\frac{B-C}{2}} - r.$$

$$\sin\frac{A}{2} = \frac{O'F-r}{OO'} = \cos\frac{B-C}{2}\,\frac{r}{b-c}\,\sin\frac{B-C}{2}.$$

Since $\frac{A}{2}$ is determined

$$B = \frac{\pi}{2} - \frac{A}{2} + \frac{B-C}{2}.$$

Hence
$$a = r\left(\cot\frac{B}{2} + \cot\frac{C}{2}\right);$$
$$b = r\left(\cot\frac{A}{2} + \cot\frac{C}{2}\right);$$
$$c = r\left(\cot\frac{A}{2} + \cot\frac{B}{2}\right).$$

Editor: A solution of this problem appears in "College Geometry," page 77, by Nathan Altshiller-Court.

904. *Proposed by J. J. Sheekey, Normal Institute, Ammendale, Md.*

Under what conditions will x^3+ax^2+bx+c be divisible by x^2+px+q?

Solved by Michael Goldberg, Philadelphia, Pa.

If
$$\frac{x^3+ax^2+bx+c}{x^2+px+q} = x+s$$

Then $x^3+(p+s)x^2+(q+sp)x+qs = x^3+ax^2+bx+c.$

Equating the coefficients of like powers of x gives

$$a = p+s,\ b = q+sp, \text{ and } c = qs.$$

The necessary and sufficient condition is that there exists an integer s such that

$$s = (a-p) = (b-q)/p = c/q.$$

Eliminating s from this set of equations gives the two required conditions

$$c = q\,(a-p),$$
$$pc = q\,(b-q).$$

Also solved by *R. T. McGregor, Elk Grove, Cal.; Norman Anning, Ann Arbor, Mich.; J. Murray Barbour, Ardmore, Pa.; T. E. N. Eaton, Redlands, Cal.; Leonard Carlitz, Philadelphia, Pa.; J. S. Georges, University High School, Chicago.*

905. *Proposed by Tillie Dantowitz, Kensington H. S., Philadelphia, Pa.*

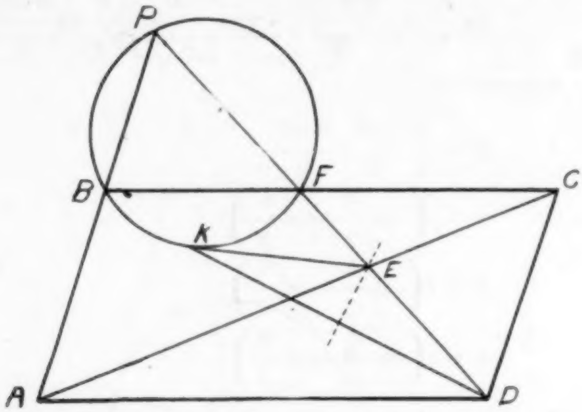
The side AB of a parallelogram ABCD is produced to point P. The line DP intersects AC at E and BC at F. A circle is drawn through B, F. and P. From E a tangent to this circle is drawn. Prove that the perpendicular bisector of DK passes through E.

Solved by Arthur Windecker, Jr., Oak Park H. S., Chicago.

Statements.

$FE : EK = EK : PE$. $(EK)^2 = FE : PE$.
$\triangle EFC \sim \triangle AED$. $AE : EC = ED : EF$.
$\triangle EPA \sim \triangle ECD$. $AE : EC = PE : ED$.
$ED : EF = PE : ED$. $(EK)^2 = (ED)^2$. $EK = ED$.

Since triangle EKD is isosceles the perpendicular bisector of DK passes through E.



Editor: This problem is the same as 756, solutions of the same appearing in January, 1923. A different solution was desired, hence the reason for it being proposed a second time.

Also solved by *Frances Crooks, High School, Bellmore, Ind.; Velma Knox, High School, Redlands, Cal.*, and the *Proposer.*

PROBLEMS FOR SOLUTION.

916. *Proposed by J. Q. McNatt, Canon City, Col.*

Each vertex of a triangle is the center of a circle which is tangent to the other two circles. The sides of the triangle are a, b, and c. Compute the radius of the internal circle, and the radius of the external circle, which is tangent to each of the given circles.

Editor: The geometrical construction for the circles has been considered in problem 618, June, 1919. This is known as the *Problem of Apollonius.*

917. *Proposed by Michael Goldberg, Philadelphia, Pa.*

Tie a flat, close knot in a strip of paper. Prove that a regular pentagon is formed.

918. *Proposed by Orville F. Barcus, Columbus, Ohio.*

To what figure should the "1" in the following number of twenty-nine digits be changed to make the number exactly divisible by 7, 13, and 37: 32,877,728,325,153,257,328,834,456,705?

919. *Proposed by Nathan Altshiller-Court, Norman, Okla.*

Construct a triangle given an angle, the external bisector of the angle, and the difference of the sides including the angle.

920. *Selected. For High School Pupils.*

In a circle of radius x is inscribed a convex hexagon whose sides are 6, 6, 6, 6, 1, 1. Find value of x.

PROFESSIONAL DRESS FOR TEACHERS OF YOUNG CHILDREN.

Colored smocks, in shades to suit individual taste, have been adopted as the professional dress for practice work with little children by students of the Cleveland kindergarten primary training school. The smocks may be used in lieu of a dress in warm weather, and may be worn over the street dress in winter. They are washable, they can be obtained in a number of bright colors, the children admire them, and they help create a cheerful atmosphere. The freedom of movement, the suitable neck lines, long sleeves, and pockets large enough to hold notebook and pencils, add to their appropriateness.—*School Life.*

AMERICAN EXPEDITION TO EXPLORE GREENLAND'S ICY MOUNTAINS.

An expedition to penetrate into the interior of the great ice sheet covering Greenland and learn the secrets of the weather in that area is being organized this winter by Prof. W. H. Hobbs, of the University of Michigan, an authority on glaciers and geology.

Equipped with airplanes for preliminary exploratory work, with radio apparatus adequate to maintain constant communication with the outside world, and with scientific instruments to record meteorological data and observe the movements of the great Greenland glaciers, the party to be headed by Prof. Hobbs will start for the far northern Danish island-continent of Greenland in July of next year.

One of its objects will be the establishment of a weather observing station on the great plateau of ice some 150 miles inland, and 6,000 to 7,000 feet above sea level. Never before has this been accomplished. Prof. Hobbs plans to maintain an observing staff at this station for a year in order to give to the meteorologists of the world information about the behavior of the weather in that part of the world which seems to be the place where storms either are born or die. The data to be radioed to civilization are expected to aid materially in the making of the daily weather forecasts in Canada and the United States.

The expedition will be under the auspices of the University of Michigan where Dr. Hobbs is professor of geology. Several American governmental bureaus interested in the scientific problems of the arctic have promised active participation in the expedition and the expedition will also cooperate informally with Dr. Lange Koch, leader of the Danish government's scientific party which will take the field at Scoresby Sound on the east coast of Greenland in July, 1926, at about the same time that Prof. Hobb's party is establishing its base nearly directly opposite on the west coast at Holstensborg, just below the arctic circle. Dr. Koch, who has had long training and experience in explorations in Greenland, will trek directly across the continent of Greenland from east to west, making scientific observations during the two months' journey. Previous to this he plans to map and investigate the geological features of the unknown portion of the west Greenland coast.

Regular exploration of the wind currents and temperatures of the upper air will be a feature of the routine observations at the two stations to be established by Prof. Hobbs. Large rubber sounding balloons will be used for this purpose. Since the inland station on the ice sheet will be over a mile high above the sea, and the coast station off the edge of the glacial ice will be over a half-mile high, it is expected that the balloons will succeed in probing and revealing the weather secrets of unusually high altitudes.

At least two airplanes with pilots and mechanics will be a part of the expedition and the rest of the party is now in the process of organization. Radio communication on short wave length will be provided between the two stations as well as with the United States. *Science Service.*

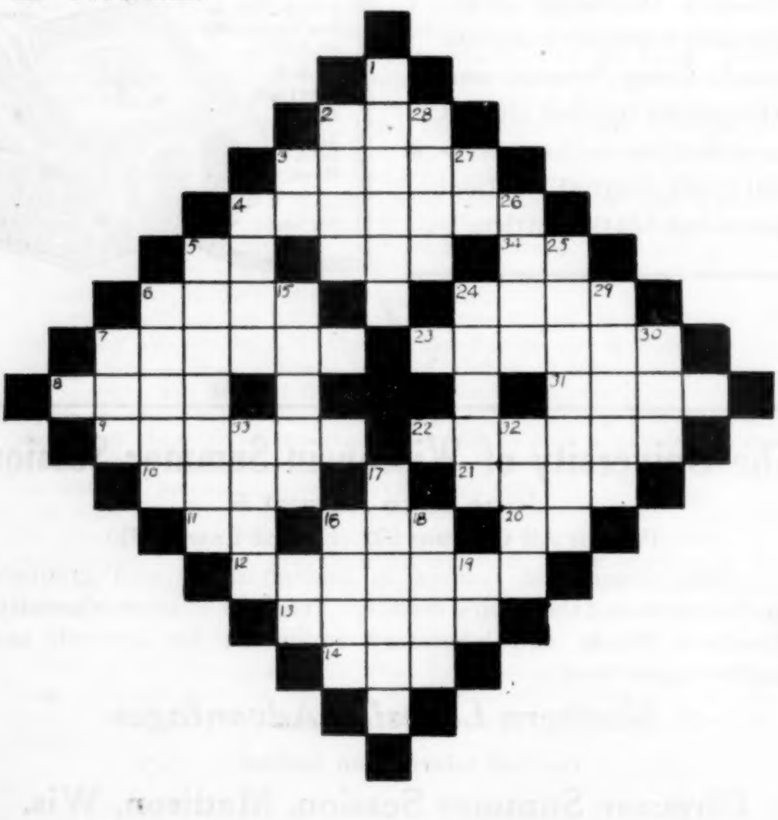
Trees are studied in public schools of New York as a part of the nature-study program, and the progress of the seasons is followed in a tree-study calendar prepared by one of the scientists of the Brooklyn Botanic Garden.

A MATHEMATICAL CROSS WORD PUZZLE.

By Professor H. C. Cosard, University of Wyoming.

HORIZONTAL.

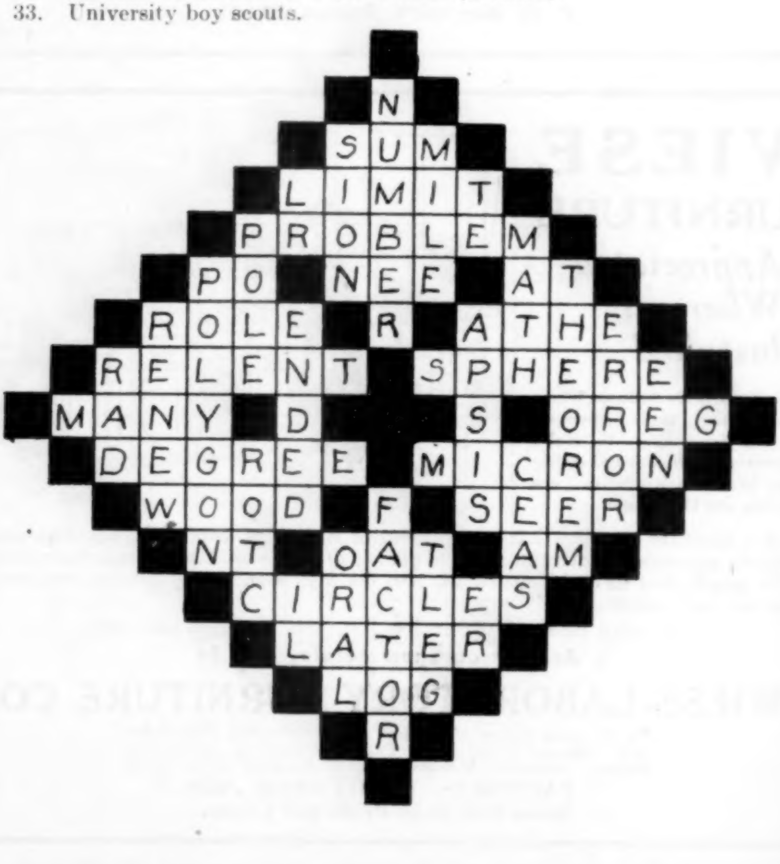
2. A simple mathematical result.
3. That which a variable constantly approaches, but can never go beyond.
4. That which works math students.
5. Abbreviation for a branch of the civil service.
6. Any assumed function.
7. To yield or soften.
8. A large number.
9. A unit of angular measurement.
10. What instructors think our heads are made of.
11. Abbreviation for niton.
12. A close figure of plane geometry (plural).
13. We will have refreshments ....
14. ....x to the base e. (Abbr.) No. big stick.
15. A cereal (singular).
20. Abbreviation for morning.
21. One who sees.
22. A Greek letter beheaded.
23. A ball.
24. Two articles.



31. Abbreviation for a state on the western coast.
34. A proposition denoting presence or nearness in time or place.

VERTICAL.

1. Nine is a ....
2. "We're marching to.................., beautiful, beautiful ...."
3. Abbrevaton for latus rectum.
4. Name of the origin in polar coordinates.
5. A plane figure bounded by straight lines.
6. To make new.
7. Square root sign (abbr.)
15. The world has not .... yet.
16. Not written.
17. Two is a .... of four.
18. T-A side of a triangle (i.e. T, and a word for a side of a triangle).
19. Suffix used to form nouns of agency.
24. A point of an eccentric orbit that is nearest to or farthest from the center of attraction.
25. A proposition setting forth something to be proved.
26. What the Mathematical Club sponsors. (abbr.)
27. Topographical engineers. (abbr.)
28. Unit of linear measurement.
29. Fallacy or hallucination.
30. Contraction of word meaning divisible by two.
32. To come to an end or to discontinue (detailed).
33. University boy scouts.



EYE SIGHT CONSERVATION.

One-third of 2,044 children under school age were tested in Gary, Indiana, and found by Federal investigators to suffer from defective vision.

These results, made public here by the Eye Sight Conservation Council of America, are set forth in a report on the Gary experiments made to Secretary of Labor James J. Davis, a member of the Council's Board of Councillors.

Complete physical examinations were made of 994 infants under two years of age and of 3,125 children whose ages ranged from two to seven years. In both groups the distribution of sex was fairly even.

The work was carried on in connection with a social and economic study of infant mortality and the pre-school child in Gary by the U. S. Children's Bureau. The study included all children under seven years of age attending the kindergartens and primary grades in all the public schools as well as in three parochial schools.

The Gary Children's Year Committee of the Council of National Defense cooperated with the Government representatives under the direction of Dr. Anna E. Rude, Director of the Child Hygiene Division of the Children's Bureau, who reported on the results to Secretary Davis.

The Eye Sight Conservation Council, in analyzing the facts obtained by Secretary Davis, asserts that "the time to begin to preserve eyesight is at birth," pointing out that rattles and other toys are common sources of infant eye strain.

"It was possible to test vision in only about two-thirds of the cases of the children who were given physical examinations," says the Council's statment, "since only the exceptional child under three years of age comprehended the test at all, even though it was made as simple as possible, compatible with accuracy, and only a very small number of children under four years did so.

"Out of the 2,044 children given vision tests, slightly more than one-third, or 36.1 per cent, showed defective sight of varying degrees, with apparently no significant relation to age, although those in their fifth year showed a slightly higher per cent than any of the others.

"In 108 cases, or 5.3 per cent of the whole number given vision tests, the vision was seriously defective in both eyes, and the need for glasses was imperative, although only ten per cent of these children so urgently in need of glasses were wearing them. The other 90 per cent were not even cognizant of the necessity.

"There was a high proportion of cross-eyes children, actually 2.4 per cent of all the children, but here again corrective glasses for this defect were being worn by only about one-seventh of those with this defect. Only one boy, out of the total of 33 boys with cross-eyes, was wearing glasses.

"Obviously, it was impossible to obtain data regarding vision in the group of 994 infants under two years of age by use of the methods employed; but twenty-three infants, or 2.3 per cent, plainly showed eye defects, and the proportion steadily increased with age.

"While the report of the Children's Bureau is entirely an analysis of statistical data with no attempt to analyze causes and effects of defects, it is quite evident from the high prevalence of defective vision that the eyesight of infants and young children calls for greater attention than has been given in the past."

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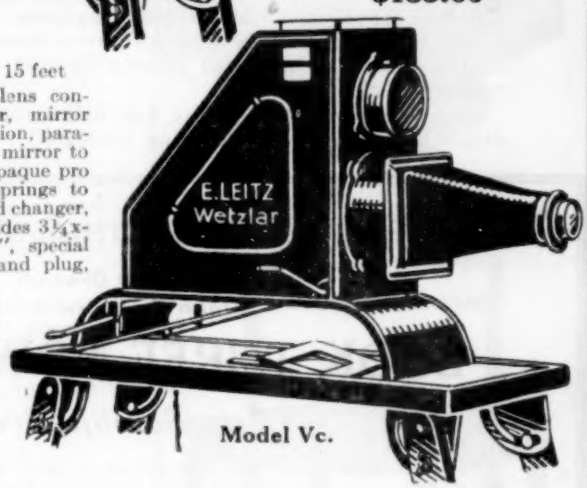

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The Eye Sight Conservation Council, after a survey called the most complete in the history of organized eye conservation, concludes that education is dependent to a large extent upon visual perception.

"In order that school children may have good eyesight it is necessary that proper care be taken of the eyes of the pre-school child in the home," declares a Bulletin of the Council which embodies the official report on this survey and which has just been made public.

"The time to begin to preserve eyesight is at birth. The eyes of all new born babes should be treated with drops to guard against infection. Since the eyes are not fully developed at birth, the baby should sleep in a darkened room for the first three or four weeks of life. Baby's eyes should never be exposed to the direct rays of the sun. A rattle or other toy hung from the top of the baby carriage is a common cause of eyestrain.

"The toys, games, puzzles and picture books used by children should be big and clear. Anything that demands close inspection in order to be seen and enjoyed is not a proper toy for a little child.

"The inadequate illumination provided in so many of our homes also inflicts severe strain upon the immature eyes of children. Children should not be allowed to play games, read, or study on the poorly lighted floor or in dark corners of the room or by the window during twilight. Unshaded glaring light is just as harmful as insufficient light.

"A child who starts out in life handicapped by poor or painful vision has a constant and losing struggle."

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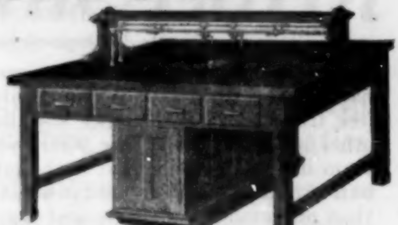

Chemical Table No. 890
Designed for use in the small school chemical laboratory. Eight students may be accommodated, working in sections of four.

Combination Physics and Chemistry Table No. 14223
This design is practical for use as a student's desk or in a private laboratory. Has two larger and eight smaller drawers and four cupboards. Very solidly constructed and finely finished.

Physics Laboratory Table No. 700
Very popular with teachers. Very substantially built. Can be supplied, if desired, with lower cupboard and drawers.

Chemical Desk No. 8020
This design contains two features not to be overlooked. The electric light attachments are new. The small drawers extending through the entire table provide storage room for long condensing tubes and other equipment. This desk will accommodate twenty-four students working in groups of eight.

GEOGRAPHY AND POLITICS.

By Hazel D. Shields,
Portland High School, Portland, Maine.

A great many of us have been grumbling and not a few of us have been hard hit by tariff laws of the United States. Do you really believe in free trade or general justice so-called? Do you believe one way or the other because of the place where you live or the occupation you follow? I am inclined to believe it is the latter. The plants or animals that are native to a place or are used in its industries influence our beliefs far more than any amount of theoretical argument.

As a congressman once put it: "We are not patriots in our treatment of the tariff. We forget the good of the country as a whole, and think only of what products we want free or protected because of the geographical conditions in our particular part of the country." The following examples of things that have actually happened in Congress when a tariff bill has been under discussion illustrate this man's thought. (1) A Massachusetts Republican, although belonging to the party that advocates protection, demanded that hides be placed on the free list. He came from the shoe manufacturing region. At the same time a Texas Democrat, whose party believes in free trade, insisted that the duty on hides be increased. The plains of Texas are excellent for cattle raising and a high duty on hides would increase the price of their skins. (2) A Louisiana Democrat demanded a protective duty on rice. (3) When the tariff on sugar was reduced by the Democrats, the Louisiana Democrats and the Michigan Republicans, representing cane and beet sugar interests, united in opposing the measure tooth and nail. (4) Senators from the Rocky Mountains dwelt upon the importance of protection of wool. (5) The representatives from California demanded protection of lemons. (6) Minerals have the same effects as plants and animals. For when the Republicans voted for free coal, a Pennsylvania Republican declared that this was a repudiation by his party of its policy of protection.

In general each part of the country wants protection and high prices for the things that it produces, and free trade and low prices for the things which it must bring from elsewhere. Manufacturers generally want a tariff on manufactured goods and free trade for raw materials and food. The rich agricultural states of the Mississippi Valley generally want low duties on manufactured goods and high duties on food. The Southern States in general favor free trade because they bring practically all their manufactured goods from a distance. Free trade does not alter materially the price of their one large export, cotton, because other parts of the world have not enough to export to America.

Sooner or later, the entire world—business and social—will learn that the secret of real freedom lies in an acknowledgment of our complete dependence upon others.

A certain well known piano manufacturing concern met with a similar experience. A few people in a small town in the heart of the mountains of Ecquador had very praiseworthy musical aspirations. By dint of much effort, they ordered some half-dozen pianos from this company here in the United States. Now, this small town, located some 3000 or more feet above sea level, had only one road of approach, accessible to only human or donkey traffic. Our piano concern, however, did not find out anything of that nature and so shipped their pianos in the usual piano boxes. The result was that the natives, not knowing the proper care for such furniture, took huge rocks, broke up the crates and pianos into easily movable pieces, carried them up the mountain road to their homes, and then sat down to patiently await the arrival of an agent or directions for putting them together again.

BRAINS MORE USEFUL THAN BEEF IN SPORTS.

The most valuable gift a baseball or football player can have isn't extraordinary strength or endurance or even speed. All of these won't keep him in the spotlight of fame if he lacks brains, according to tests being made by Dr. C. H. Bean, psychologist at the University of Louisiana.

The quality which Red Grange, Illinois football star, regards as most important in his success really comes second, said Dr. Bean. This quality has been described as "the perceiving of motion of several men in terms of a player's own motion, so that he knows where all of them will be when he himself reaches a desired position."

"But intelligence is so important in this," explains Dr. Bean, "that if intelligence is left out, as it can be by mathematical calculation, the mere speed of reaction to a situation is secondary."

Muscular strength and endurance rank third among the factors of success thus far measured, and weight or "beef" is fourth.

All this is true for such sports as football, baseball, and basketball, but when it comes to track and field events intelligence becomes less vital and physical qualities take a rise in value, the tests indicate.

Dr. Bean is making a job analysis of athletics in order to find out definitely what makes one man a star in sports and another a dub. He also hopes to show to what extent athletic training develops those factors which are most needed in practical life. Results shown by the scientific tests of speed, intelligence, endurance, strength, and judgment are being compared with the ratings given to the athletes by their instructors and coaches.

In order to measure the speed with which different athletes respond to a situation, a special piece of apparatus has been devised. A series of pictures is shown to the athlete, and as soon as he sees each one and recognizes its meaning, he is expected to take a leap. If he would like to experience what he sees in the picture he leaps forward, but if he would dislike it he is expected to leap back.—*Science Service.*

INTERESTING SUMMER SESSION ANNOUNCEMENT.

Dr. I. O. Foster, Director of the Summer Session of Battle Creek College, Battle Creek, Mich., announces as a part of the Summer Session of his institution for the coming year a plan that may be of interest to some of our readers. An opportunity is given to a number of professors who have attained national reputation or who have made distinctive contributions to the various fields of education to spend their summer at Battle Creek College, vacationing in the "Little Lake District" of Michigan and to receive all expenses and free treatment from the Battle Creek Sanitarium in lieu of the teaching of one or two classes in the College. A few positions still remain unfilled.

A second interesting feature is that unusual opportunity is offered to the teachers, both in public and private schools, to take advantage of the great opportunities offered them at the Battle Creek Sanitarium and to attend college at the same time at a combined expense practically no greater than that charged by the average educational institution. The College is willing to do this because of its great ideals of race betterment and feels that it not only can profit by these arrangements, but that the various institutions throughout the country and the public in general may benefit by them. The modern summer camp for girls situated on an island in beautiful Gull Lake offers an added attraction for a pleasant and profitable summer.

Another interesting project relates to school administration. The College is undertaking to offer partially simultaneously both an eight-weeks term and a six-weeks term to its patrons, the former beginning June 24th, and the latter July 8th, both closing August 17th.

INTERNATIONAL CONGRESS OF PLANT SCIENCES.

(Fourth International Botanical Congress.)

Investigators and teachers in the plant sciences, representing all aspects of botany, plant chemistry, plant pathology, and bacteriology, agronomy, horticulture, and forestry are invited to attend the International Congress of Plant Sciences to be held at Ithaca, N Y., August 16-23, 1926. This invitation is extended to all countries of the world.

In order that a part of the program may be representative of outstanding leadership, the Congress will be divided into about one dozen sections, each section with an invitation program occupying about four morning sessions or a little more than one-fourth of the available time. These formal programs will be supplemented by another feature that promises also to be of exceptional interest. Ample time will be set apart for round table or informal discussions, which in some cases may be scheduled in advance, and in others may be arranged both as to topics and participation after the Congress actually convenes. This is intended to provide for the widest participation in sectional activities. Supplementary opportunities for individual contact and participation are made possible through the non-commercial exhibits and through the provision for excursions and inspection tours of various types suited to the diverse needs of the different sections.

Although the Congress is not to provide an occasion for *legislation* on regulatory matters of international significance (such as nomenclatorial rules), the organizing committee has expressly provided that "adequate opportunity shall be accorded all sections for the *discussion* of regulatory recommendations of international significance," in order that a better understanding may be reached for definite action at a subsequent international congress.

The sections thus far authorized and the secretaries representing these groups are as follows:

Agronomy—C. H. Myers, Cornell University, Ithaca, N. Y.
Bacteriology—J. M. Sherman, Cornell University, Ithaca, N. Y.
Cytology—L. W. Sharp, Cornell University, Ithaca, N. Y.
Morphology, Histology and Paleobotany—D. S. Johnson, Johns Hopkins University, Baltimore, Md.
Ecology—H. L. Shantz, Bureau of Plant Industry, Washington, D. C.
Forestry—R. S. Hosmer, Cornell University, Ithaca, N. Y.
Horticulture—A. J. Heinicke, Cornell University, Ithaca, N. Y.
Physiology—G. F. Curtis, Cornell University, Ithaca, N. Y.
Pathology—Donald Reddick, Cornell University, Ithaca, N. Y.
Pharmacognosy & Pharmaceutical Botany—H. W. Youngken, Massachusetts Col. of Pharmacy, Boston.
Taxonomy—K. M. Wiegand, Cornell University, Ithaca, N. Y.
Mycology—H. M. Fitzpatrick, Cornell University, Ithaca, N. Y.
Genetics—C. E. Allen, University of Wisconsin, Madison, Wis.

Communications regarding the Congress should be addressed as indicated below:

(1) Concerning round tables and other strictly sectional matters—to the appropriate sectional secretary.

(2) Concerning exhibits and general program matters—L. W. Sharp, Cornell University, Ithaca, N. Y.

(3) Concerning excursions, collecting trips, inspection tours, local arrangements, transportation, etc.—H. H. Whetzel, Cornell University, Ithaca, N. Y.

(4) Concerning the Congress in general—B. M. Duggar, Missouri Botanical Garden, St. Louis, Mo.

CONVENTION ON VOCATIONAL AND ART EDUCATION, DES MOINES, IOWA, MARCH 17-20, 1926.

A meeting of considerable importance to all forms of practical education will be held on the above dates, at Des Moines, Iowa.

The Western Arts Association and the Vocational Education Association of the Middle West will meet in joint session. A program dealing with vocational and art education as related to industry, commerce, agriculture, household arts, guidance and personnel work will be presented. Speakers of national reputation will discuss these topics. The convention will summarize the results which have been accomplished and make plans for the future expansion of this work.

The value of this work in our schools has sometimes been questioned by the layman. Every wide-awake community in the Middle West should have a representative present, either from the school system or from a prominent business organization such as the Rotary Club, Kiwanis, or Commercial Club, to check the results of this work and bring back progressive ideas to improve the work of their schools.

The Des Moines public schools will be well worth inspection, and the Iowa State College at Ames, 30 miles from Des Moines, is planning to entertain visitors and show the results accomplished in this institution.

Further information regarding the meeting may be obtained from J. W. Studebaker, Chairman of the Local Committee, and Superintendent of Schools, Des Moines, Iowa.

BOOKS RECEIVED.

Arithmetic for Teachers, by William F. Roantree and Mary S. Taylor. Pages Old Roman xiii+Arabic, 621. 13x19 cm. Cloth, 1925. Macmillan Company, New York.

Exercises in General Chemistry, by William Foster, Harley H. Heath, Lawrenceville School, New Jersey. Pages Roman xi+186. 14x20½ cm. Cloth, 1925. $1.25. D. Van Nostrand, 8 Warren Street, New York, N. Y.

Exercises in Practical Physics by Arthur Schuster, University of Manchester, Manchester, and Charles H. Lees, University of London, London, England. Pages Roman x+379. 14½x22 cm. Cloth, 1915. Cambridge University Press, England.

Cumulative Mathematics, by D. M. Werremeyer, West Technical High School, Cleveland, Ohio. Pages Roman xi+222. 14x19 cm. Cloth, 1925. Harcourt Brothers & Co., New York, N. Y. 8th year.

Cumulative Mathematics by D. M. Werremeyer, West Technical High School, Cleveland, Ohio. Pages Roman x+231. 14x19 cm. Cloth, 1925. Harcourt Brothers & Co., New York, N. Y.

Six Place Tables by Edward S. Allen, Iowa State College. Pages xxiii+144. 10½x18 cm. Cloth, 1925. $1.25. McGraw-Hill Book Company, 370 7th Ave., New York, N. Y.

Forty Years of Service by D. C. Heath & Company. Pages 61. 15½x 23½ cm. Cloth, 1925. D. C. Heath & Company.

Health Habits, book one, by William B. Burkard, Raymond L. Chambers, Philadelphia Public Schools and Frederick W. Maroney, Dept. of Health, Atlantic City. Illustrated by Vera Stone Norman. 429 pages. 14x19 cm. Cloth, 1925. Lions and Carnahan.

Health Habits, book two, by William B. Burkard, Raymond L. Chambers, Philadelphia Public Schools and Frederick W. Maroney, Dept. of Health, Atlantic City. Illustrated by Vera Stone Norman. Pages 429. 14x19 cm. Cloth, 1925. Lions and Carnahan.

Introduction to Earth History by Hervey W. Shimer, Massachusetts Institute of Technology. Pages viii+411. 14x21 cm. Cloth, 1924. $3.00. Ginn Company, Boston, Mass.

Methods of Handling Test Scores by Luella C. Pressey and Sydney L. Pressey of Ohio State University. Pages iv and 60. 13x18 cm. Paper, 1926.

Cycles of Garden and Plant Life by Florence C. Fox. Pages vii and 98. 15x23 cm. Paper, 1928. Price 25 cents. Government Printing Office, Washington, D. C.

Back numbers of School Science, School Mathematics, and School Science and Mathematics may be held for 35 cents a single. The Mathematical Supplements for 20 cents a copy. In sets, the prices are, postpaid:

School Mathematics and Supplements, Vol. I, five numbers	$1.10
School Science, Vol. I, seven numbers	5.75
School Science, Vols. II, 7 numbers	5.00
School Science, Vol. III, eight numbers	5.50
School Science, Vol. IV, three numbers	.85
School Science and Mathematics, Vols. V, VI, VII, VIII, IX, X, XI, XII, XIII, XIV, XV, XVI and XVII, each	2.75
School Science and Mathematics, Vols. XVIII, XIX, XX, XXI, XXII, XXIII and XXIV, each	2.75

Elementary Mathematical Analysis by Charles S. Slichter and Warren Weaver of the University of Wisconsin. Pages xviii+473. 13x19 cm. Cloth, 1925. McGraw Hill Book Co., 370 Seventh Ave., N. Y. C.

Geometry Reader by Julius J. H. Hayn, Master Park High School, Buffalo. 119 pages. 14x20 cm. Cloth, 1925. Bruce and Putnam Co., Milwaukee, Wis.

BOOK REVIEWS.

Laboratory Manual of Chemistry by Ernest L. Dinsmore, Chairman of Chemistry Department, Boys' High School, Brooklyn, N. Y. First edition. Pages 164. 20x26.5x1 cm. Line drawings. Loose leaf type. 1925. F. M. Ambrose Co., New York and Boston.

This new loose leaf manual was written to accompany the author's "Chemistry for Secondary Schools," but it has such a large number of experiments in it that it could very well be used with almost any text. The list includes all experiments essential for passing the College Entrance Board Examinations as well as those of the Regents of the state of New York. A casual examination of the manual impresses us favorably. The directions to the pupil are exceptionally clear, they are sufficient, the leading questions go straight to the heart of the principles involved and adequate guidance is given so that a good writeup should result. Among the experiments are many which might well be given to the brighter pupils to keep them employed and growing or they might be given to project classes. The synthesis of nitric acid and the preparation of nitric acid from it, for example, is one such experiment. The drawings are excellent and the apparatus called for is such as is available in most laboratories. High School Chemistry teachers should see this manual. F. B. W.

Inorganic Quantitative Analysis by Harold A. Fales, Ph. D. Associate Professor of Chemistry at Columbia University. 14x20.5x2 cm. Pages xii+493. Cloth. Numerous diagrams, curves, tables and a number of line drawings of apparatus. Five place log. tables. 1925. Price, $3.50. The Century Co., New York.

The most noteworthy feature of this new quantitative analysis text, as the reviewer sees it, is the generous amount of attention given to the teaching of the principles of chemistry involved in the determinations and separations about to be made. Students as a rule pay most attention to and profit most from the study of things that are of immediate use, thus the method of this book is pedagogically good. The student is not left with a mere manual of directions, supplemented by lectures, but has always available the text book portions of this book in which he can study out at his leisure the principles and their applications to the work in hand. The first few chapters introduce the subject and give general directions in regard to apparatus, reagents, general operations, precision, weighing and volumetric measurements. The usual types of analysis are then taken up in separate chapters. These include Acidimetry-Alkalimetry, gravimetric and volumetric determination of chlorine, determination of sulphur and phosphorus, calcium and magnesium, zinc (both gravimetrically and volumetrically), nickel, oxidimetrical determinations of iron and of manganese, iodimetrical determinations, electrolytic determinations, methods involving the liberation and determination of gases, introduction to systematic analysis with analysis of silicates and determination of sodium and potassium, analysis of ferrous and non ferrous alloys, and procedures for tungsten steel, brass and solders. An appendix with five place log. tables and various physical-chemical tables completes the book. A brief inspection of various parts of the book gives us great respect for the competent care which must have been given to its preparation. College teachers of quantitative analysis should want to see this text-manual. Although the reviewer had a most competent professor in qualitative analysis there were many times in the course when such a book as this would have been invaluable.

F. B. W.